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Department of **Biodiversity, Conservation and Attractions**

The cover of Volume 29 of *Nuytsia* features a diminutive *Peplidium* Delile (Phrymaceae), which was observed flowering en masse in Western Australia's Murchison region in 2016. Photograph: Jean and Fred Hort.

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Nuytsia

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SHORT COMMUNICATION

Updates to Western Australia's vascular plant census for 2017

The census database at the Western Australian Herbarium (PERTH), which provides the nomenclature for the website *FloraBase* (Western Australian Herbarium 1998–), lists current names and recent synonymy for Western Australia's native and naturalised vascular plants, as well as algae, bryophytes, lichens, slime moulds and some fungi. The names represented in the census are either sourced from published research or denote as yet unpublished names based on herbarium voucher specimens. We herein summarise the changes made to vascular plant names in this database during 2017.

Sixty-five taxa were newly recorded for the State, of which eight are naturalised and 33 have been added to the *Threatened and Priority Flora list for Western Australia* (Smith 2017; Western Australian Herbarium 1998–) (Table 1). A total of 201 name changes were made (Table 2). Plant groups for which a number of name changes were made include *Brachyloma* Sond. (Hislop & Cranfield 2017), *Eremophila* R.Br. (Buirchell & Brown 2016), *Hibbertia* Andrews (Thiele 2017a, 2017b; Thiele & Nge 2017), *Stylidium* Sw. (Lowrie & Kenneally 2017; Wege 2017b) and *Triodia* R.Br. (Anderson *et al.* 2017). Numerous phrase names in *Leucopogon* R.Br. were formally published (Hislop 2016a) with some being transferred to the newly circumscribed genus *Styphelia* Sm. (Hislop & Puente-Lelièvre 2017). Several changes were made in *Daviesia* Sm. following the publication of a monograph for the group (Crisp *et al.* 2017). A single manuscript name was changed to a phrase name under Council of Heads of Australasian Herbaria (CHAH) guidelines for informal names (Barker 2005), while two manuscript names and 58 phrase names were formally published (Table 2). Table 2 also includes cases where there has been a change of taxonomic concept, misapplication, exclusion or rank change.

PERTH largely follows the family circumscriptions of the Angiosperm Phylogeny Group (APG). To align with their latest classification (APG IV: Angiosperm Phylogeny Group 2016) the following changes were made to family placements: *Anacampseros* L. (from Portulacaceae to Anacampserotaceae), *Calandrinia* Kunth. and *Montia* L. (from Portulacaceae to Montiaceae), *Macarthuria* Endl. (from Molluginaceae to Macarthuriaceae), and *Melianthus* L. (from Melianthaceae to Francoaceae).

Table 1. New records added to Western Australia's vascular plant census during 2017. *in litt.* = in correspondence; *in sched.* = on herbarium sheet/label; * = naturalised; T, P1–P4 = Conservation Codes for Western Australian Flora (Smith 2017; Western Australian Herbarium 1998–).

New Name	Status	Comments
Androcalva sp. York (C.F. Wilkins & A. Sole CW 2527)	P1	C.F. Wilkins *in litt.* (19/10/2017).
Astartea arbuscula (Benth.) Rye × *Astartea corniculata* Schauer		See Rye (2013).
Bergia occultipetala G.J.Leach	P3	New record for WA. R. Butcher *in litt.* (28/03/2017).
Brachyloma elusum Hislop & Cranfield	P2	See Hislop & Cranfield (2017).

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New Name	Status	Comments
Caesia sp. Hopetoun (T.D. Macfarlane & C.J. French TDM 5228)	P1	T.D. Macfarlane *in litt.* (22/08/2017).
Calandrinia sp. Boolardy Station (P. Jayasekara 719-JHR-01)	P1	F. Obbens *in litt.* (19/01/2017).
Calandrinia sp. Menzies (F. Hort et al. FH 4100)	P3	F. Obbens *in litt.* (21/03/2017).
Calandrinia sp. Shark Bay (A. Markey 1405)		F. Obbens *in litt.* (19/01/2017).
Chamaescilla maculata R.W.Davis & A.P.Br.	P1	See Davis & Brown (2017).
Colophospermum mopane (Benth.) J.Léonard	*	New naturalised record for WA. G.J.Keighery *in litt.* (06/06/2017).
Cortaderia selloana (Schult. & Schult.f.) Asch. & Graebn. subsp. *selloana*	*	New naturalised record for WA. G.J.Keighery *in litt.* (18/01/2017).
Cucumis sp. Bastion Range (A.A. Mitchell et al. AAM 10710)	P1	A.A. Mitchell *in litt.* (22/06/2016).
Cucumis sp. Chichester Range (A.A. Mitchell et al. AAM 10691)		A.A. Mitchell *in litt.* (22/06/2016).
Daviesia scabrella Crisp		See Crisp *et al.* (2017).
Diuris cruenta D.L.Jones & C.J.French		See Jones & French (2016).
Diuris porphyrochila D.L.Jones & C.J.French		See Jones & French (2016).
*Elacholom*a sp. Showy flowers (C.P. Campbell 1762)		See Barker *et al.* (2012).
Eremophila victoriae Buirchell & A.P.Br.	P1	See Buirchell & Brown (2016).
Eriocaulon truncatum Mart.		New record for WA. See Leach (2017).
Eucalyptus cladocalyx subsp. *petila* D.Nicolle	*	New naturalised record for WA. G.J.Keighery *in litt.* (10/12/2014).
Eucalyptus grandis W.Hill	*	New naturalised record for WA. G.J.Keighery *in litt.* (22/09/2017).
Eucalyptus saligna Sm.	*	New naturalised record for WA. G.J.Keighery *in litt.* (16/01/2017).
Galium palustre L.	*	New naturalised record for WA. G.J.Keighery *in litt.* (06/02/2017).
Gnephosis newbeyi P.S.Short		See Short (2016).
Gompholobium sp. Stirling Range (C.F. Wilkins et al. CW 2513)	P2	C.F. Wilkins *in litt.* (04/05/2017).
Goodenia asteriscus P.J.Lang	P3	See Lang & Davies (2017).
Goodenia halophila Albr.	P3	New record for WA. R. Butcher *in litt.* (28/03/2017).
Hibbertia depilipes K.R.Thiele		See Thiele (2017a).
Hibbertia polyancistra K.R.Thiele	P1	See Thiele (2017a).

New Name	Status	Comments
Hibbertia sp. Sherwood Breakaways (R.J. Cranfield 6771)	P1	K.R. Thiele *in litt.* (05/09/2017).
Hibbertia striata (Steud.) K.R.Thiele		See Thiele (2017b).
Hibiscus diversifolius Jacq. subsp. *diversifolius*	*	New naturalised record for WA. M.O.Badry *in sched.* (20/04/2016).
Hydrocotyle phoenix A.J.Perkins	P2	See Perkins (2017a).
Hydrocotyle serendipita A.J.Perkins	P2	See Perkins & Dilly (2017).
Lasiopetalum occidentale K.A.Sheph. & C.F.Wilkins		See Shepherd & Wilkins (2017).
Lasiopetalum sp. Wellstead (K.A. Shepherd & C.F. Wilkins KS 1650)	P1	K.A. Shepherd & C. Wilkins *in litt.* (06/09/2017).
Lepilaena patentifolia E.L.Robertson		New record for WA. T.D. Macfarlane *in litt.* (21/02/2017).
Lindernia barkeri Wannan		See Wannan (2016).
Nymphoides walshiae R.W.Davis & K.R.Thiele	P1	See Davis *et al.* (2016).
Peplidium sp. Tanami (P.K. Latz 11904)	P2	New record for WA. R. Butcher *in litt.* (28/03/2017).
Philotheca sp. Latham (F. Keast L4B 043)	P1	J.A. Wege & M. Hislop *in litt.* (08/03/2017).
Pterostylis crebriflora (D.L.Jones & C.J.French) D.L.Jones & C.J.French		See Jones & French (2017).
Pterostylis eremaea (D.L.Jones & C.J.French) D.L.Jones & C.J.French		See Jones & French (2017).
Pterostylis fuliginosa (D.L.Jones & C.J.French) D.L.Jones & C.J.French	P2	See Jones & French (2017).
Pterostylis heberlei (D.L.Jones & C.J.French) D.L.Jones & C.J.French		See Jones & French (2017).
Pterostylis virens (D.L.Jones & C.J.French) D.L.Jones & C.J.French	P3	See Jones & French (2017).
Pterostylis xerampelina (D.L.Jones & C.J.French) D.L.Jones & C.J.French	P1	See Jones & French (2017).
Ptilotus sp. Doolgunna (D. Edinger 4419)	P1	R. Davis & T. Hammer *in litt.* (16/10/2017).
Quercus suber L.	*	New naturalised record for WA. See Lohr & Keighery (2016).
Schoenoplectiella lateriflora (J.F.Gmel.) Lye var. *lateriflora*		See Hayasaka (2012).
Schoenoplectiella mucronata (L.) J.Jung & H.K.Choi var. *mucronata*		See Hayasaka (2012).
Senna artemisioides subsp. *alicia* Randell	P3	New record for WA. R. Butcher *in litt.* (28/03/2017).
Senna artemisioides subsp. *quadrifolia* Randell		New record for WA. M. Hislop pers. comm. (Sept. 2016).
Sida sp. Limestone (D.E. Albrecht 5748)		New record for WA. A.A. Mitchell *in litt.* (28/02/2017).

New Name	Status	Comments
Solanum sp. Mosquito Creek (A.A. Mitchell et al. AAM 10795)	P1	A.A. Mitchell *in litt.* (01/09/2017).
Stylidium salmoneum Lowrie & Kenneally		See Lowrie & Kenneally (2017).
Synostemon umbrosus I.Telford & J.J.Bruhl	P1	See Telford *et al.* (2016).
Tephrosia sp. Durack River (C.A. Gardner 9938)	P1	R. Butcher *in litt.* (11/10/2017).
Triodia chichesterensis B.M.Anderson	P3	See Anderson *et al.* (2017).
Triodia infesta B.M.Anderson & M.D.Barrett	P2	See Anderson *et al.* (2017).
Triodia latzii Lazarides	P3	New record for WA. R. Butcher *in litt.* (28/03/2017).
Triodia nana B.M.Anderson	P1	See Anderson *et al.* (2017).
Utricularia geoffrayi Pellegr.		New record for WA. See Lowrie (2014).
Xerochrysum boreale Paul G.Wilson	P3	See Wilson (2017).
Xerochrysum interiore Paul G.Wilson		See Wilson (2017).

Table 2. Changes to existing entries in Western Australia's vascular plant census during 2017. Excluded taxon = a name used in the botanical literature that refers to a taxon never occurring in WA; misapplied name = a name used in the botanical literature but now considered to refer to one or more different WA taxa; nomenclatural synonym = a superseded name based on the same type specimen as the accepted name—the epithet is usually transferred to a different genus name or rank; taxonomic synonym = a superseded name based on a different type specimen to the accepted name; orthographic variant = mis-spelling of a name in original publication; *in litt.* = in correspondence; *in sched.* = on herbarium sheet/label. Status: * = naturalised; T, P1–P4 = Conservation Codes for Western Australian Flora (Smith 2017; Western Australian Herbarium 1998–).

Old Name	New Name	Status	Comments
Asterolasia nivea (Paul G.Wilson) Paul G.Wilson	*Asterolasia grandiflora* (Hook.) Benth.	P4	Taxonomic synonym. See Wege (2017a).
Asterolasia pallida subsp. *hyalina* Paul G.Wilson	*Asterolasia hyalina* (Paul G.Wilson) Wege	P2	Nomenclatural synonym. See Wege (2017a).
Asterolasia pallida Benth. subsp. *pallida*	*Asterolasia pallida* Benth.		Nomenclatural synonym. No subspecies recognised. See Wege (2017a).
Asterolasia sp. Kalgan River (S.Barrett 1522)	*Asterolasia hyalina* (Paul G.Wilson) Wege	P2	Name synonymised. See Wege (2017a).
Baeckea crassifolia Lindl.	n/a		Excluded taxon. See Rye (2017a).
Baeckea crassifolia var. *icosandra* Benth.	*Rinzia icosandra* (Benth.) Rye		Nomenclatural synonym. See Rye (2017a).
Baeckea polystemonea F.Muell.	*Rinzia polystemonea* (F.Muell.) Rye		Nomenclatural synonym. See Rye (2017a).

Old Name	New Name	Status	Comments
Baeckea sp. Bullfinch (K.R.Newbey 5838)	*Rinzia fimbriolata* Rye	P1	Taxon formally published. See Rye (2017a).
Baeckea sp. East Yuna (R. Spjut & C. Edson 7077)	*Baeckea* sp. Dudawa (M.E. Trudgen MET 5369)		Name synonymised. B.L. Rye *in litt.* (11/01/2017).
Baeckea sp. Hyden (J.M. Brown 141)	*Anticoryne melanosperma* Rye	P3	Taxon formally published. See Rye (2017c).
Baeckea sp. Merredin (K.R. Newbey 2506)	*Rinzia torquata* Rye & Trudgen	P3	Taxon formally published. See Rye (2017a).
Baeckea sp. Parker Range (M. Hislop & F. Hort MH 2968)	*Rinzia triplex* Rye & Trudgen	P3	Taxon formally published. See Rye (2017a).
Brachyloma djerral Cranfield ms	*Brachyloma djerral* Cranfield & Hislop	P3	Taxon formally published. See Hislop & Cranfield (2017).
Brachyloma ericoides subsp. *occidentale* Cranfield ms	*Brachyloma geissoloma* (F.Muell.) Cranfield		Name synonymised. See Hislop & Cranfield (2017).
Brachyloma geissoloma subsp. *collinum* Cranfield ms	*Brachyloma geissoloma* (F.Muell.) Cranfield		Name synonymised. See Hislop & Cranfield (2017).
Brachyloma geissoloma subsp. *ovatum* Cranfield ms	*Brachyloma geissoloma* (F.Muell.) Cranfield		Name synonymised. See Hislop & Cranfield (2017).
Brachyloma jillup Cranfield ms	*Brachyloma preissii* Sond.		Name synonymised. See Hislop & Cranfield (2017).
Brachyloma moolya Cranfield ms	*Brachyloma geissoloma* (F.Muell.) Cranfield		Name synonymised. See Hislop & Cranfield (2017).
Brachyloma pirara Cranfield ms	*Brachyloma pirara* Cranfield & Hislop	P2	Taxon formally published. See Hislop & Cranfield (2017).
Brachyloma preissii subsp. *lanceolatum* Cranfield ms	*Brachyloma preissii* Sond.		Name synonymised. See Hislop & Cranfield (2017).
Brachyloma preissii subsp. *obtusifolium* Cranfield ms	*Brachyloma preissii* Sond.		Name synonymised. See Hislop & Cranfield (2017).
Brachyloma tamminense Cranfield ms	*Brachyloma preissii* Sond.		Name synonymised. See Hislop & Cranfield (2017).
Caesia talingka C.Tauss ms	*Caesia* sp. Great Victoria Desert (C. Tauss 2835)	P2	Name synonymised. To align with CHAH phrase name protocols. R. Butcher *in litt.* (29/05/2017).
Caladenia × *ornata* Hopper & A.P.Br.	*Caladenia* × *hopperi* J.M.H.Shaw	P1	Nomenclatural synonym. See Shaw (2014).
Calandrinia sp. Black angular seeds (A.A. Mitchell PRP 1661)	*Calandrinia holtumii* Obbens & L.P.Hancock		Taxon formally published. See Obbens *et al.* (2017).
Caldesia oligococca (F.Muell.) Buchenau	*Albidella oligococca* (F.Muell.) Lehtonen		Nomenclatural synonym. See Lehtonen (2017).
Calocephalus aervoides (F.Muell.) Benth.	*Balladonia aervoides* (F.Muell.) P.S.Short	P3	Nomenclatural synonym. See Short (2016).
Calocephalus sp. Wittenoom (A.S. George 1082)	*Calocephalus pilbarensis* P.S.Short		Taxon formally published. See Short (2016).
Calytrix sp. Eneabba (B.J. Lepschi & T.R. Lally BJL3617)	*Calytrix cravenii* Nge & K.R.Thiele		Name synonymised. See Nge *et al.* (2017).
Calytrix sp. Esperance (M.A. Burgman 4268A)	*Calytrix hirta* (Regel) Nge & K.R.Thiele		Name synonymised. See Nge *et al.* (2017).

Old Name	New Name	Status	Comments
Calytrix sp. Scarp (H. Bowler 270)	*Calytrix acutifolia* (Lindl.) Craven		Name synonymised. See Nge *et al.* (2017).
Calytrix sp. Tutunup (G.J. Keighery & N. Gibson 2953)	*Calytrix retrorsifolia* Nge & Keighery	P2	Taxon formally published. See Nge *et al.* (2017).
Calytrix sp. Wheatbelt (R. Davis 4544)	*Calytrix cravenii* Nge & K.R.Thiele		Name synonymised. See Nge *et al.* (2017).
Capparis spinosa var. *nummularia* F.M.Bailey	*Capparis spinosa* subsp. *nummularia* (DC.) Fici		Nomenclatural synonym. See Fici (2015).
Chenopodium benthamii Iamonico & Mosyakin	*Rhagodia latifolia* (Benth.) Paul G.Wilson		Nomenclatural synonym. K.A. Shepherd *in litt.* (31/08/2017).
Chenopodium benthamii Iamonico & Mosyakin subsp. *benthamii*	*Rhagodia latifolia* (Benth.) Paul G.Wilson subsp. *latifolia*		Nomenclatural synonym. K.A. Shepherd *in litt.* (31/08/2017).
Chenopodium benthamii subsp. *rectum* (Paul G.Wilson) Iamonico & Mosyakin	*Rhagodia latifolia* subsp. *recta* Paul G.Wilson		Nomenclatural synonym. K.A. Shepherd *in litt.* (31/08/2017).
Chthonocephalus multiceps J.H.Willis	*Balladonia multiceps* (J.H.Willis) P.S.Short	P2	Nomenclatural synonym. See Short (2016).
Conostephium pungens Keighery	*Stenanthera pungens* (Keighery) Hislop	P2	Nomenclatural synonym. See Hislop (2016b).
Conostylis crassinervia J.W.Green	*Conostylis crassinerva* J.W.Green		Orthographic variant. See Hopper *et al.* (1987).
Conostylis crassinervia subsp. *absens* Hopper	*Conostylis crassinerva* subsp. *absens* Hopper		Orthographic variant. See Hopper *et al.* (1987).
Conostylis crassinervia J.W.Green subsp. *crassinervia*	*Conostylis crassinerva* J.W.Green subsp. *crassinerva*		Orthographic variant. See Hopper *et al.* (1987).
Cortaderia jubata (Lemoine) Stapf	*Cortaderia selloana* subsp. *jubata* (Lemoine) D.Testoni & Villamil	*	Nomenclatural synonym. See Testoni & Villamil (2014).
Cynodon ambiguus (Ohwi) P.M.Peterson	n/a		Excluded taxon. Only known from cultivated material in WA. See Nightingale *et al.* (2005).
Cynoglossum suaveolens R.Br.	*Hackelia suaveolens* (R.Br.) Dimon & M.A.M.Renner	*	Nomenclatural synonym. See Dimon & Renner (2017).
Daviesia benthamii subsp. *acanthoclona* (F.Muell.) Crisp	*Daviesia aphylla* Benth.		Taxonomic synonym. See Crisp *et al.* (2017).
Daviesia benthamii Meisn. subsp. *benthamii*	*Daviesia benthamii* Meisn.		Nomenclatural synonym. No subspecies recognised. See Crisp *et al.* (2017).
Daviesia decurrens subsp. Hamata (M.D. Crisp 6610)	*Daviesia decurrens* subsp. *hamata* (Crisp) Crisp & G.Chandler		Taxon formally published. See Crisp *et al.* (2017).
Daviesia divaricata subsp. Lanulosa (W.E. Blackall 2733)	*Daviesia divaricata* subsp. *lanulosa* Crisp & G.Chandler		Taxon formally published. See Crisp *et al.* (2017).
Daviesia elongata Benth. subsp. *elongata*	*Daviesia elongata* Benth.	T	Nomenclatural synonym. No subspecies recognised. See Crisp *et al.* (2017).
Daviesia elongata subsp. *implexa* Crisp	*Daviesia implexa* (Crisp) Crisp	P3	Nomenclatural synonym. See Crisp *et al.* (2017).

Old Name	New Name	Status	Comments
Daviesia sp. Kanandah (R. Davis 10604)	*Daviesia aphylla* Benth.		Name synonymised. M.D. Crisp *in sched.* (24/10/2016).
Daviesia sp. Subulata (T.R. Lally & B.J. Lepschi 1091)	*Daviesia subulata* Crisp & G.Chandler		Taxon formally published. See Crisp *et al.* (2017).
Diuris sp. Western Wheatbelt (G.J. Keighery & N. Gibson 6951)	*Diuris brachyscapa* D.L.Jones & C.J.French		Name synonymised. See Jones & French (2016).
Dodonaea hispidula var. Phylloptera (F. von Mueller s.n. MEL 101393)	*Dodonaea hispidula* var. *phylloptera* (F.Muell.) M.G.Harr.		Name synonymised. See Harrington & Gadek (2010).
Dolichandrone heterophylla (R.Br.) F.Muell.	*Dolichandrone occidentalis* Jackes		Misapplied name. See Jackes (2017).
Elytrigia repens B.D.Jacks.	*Elytrigia repens* (L.) Nevski	*	Taxonomic synonym. See CHAH (2016).
Eremophila forrestii subsp. Pingandy (M.E. Trudgen 2662)	*Eremophila pusilliflora* Buirchell & A.P.Br.	P2	Name synonymised. See Buirchell & Brown (2016).
Eremophila sp. Ballythunna (R. Davis 11395)	*Eremophila ballythunnensis* Buirchell & A.P.Br.	P1	Taxon formally published. See Buirchell & Brown (2016).
Eremophila sp. Jigalong (B. Buirchell BB 204)	*Eremophila capricornica* Buirchell & A.P.Br.	P1	Taxon formally published. See Buirchell & Brown (2016).
Eremophila sp. Lorna Glen (R.J. Dadd 16)	*Eremophila daddii* Buirchell & A.P.Br.	P1	Taxon formally published. See Buirchell & Brown (2016).
Eremophila sp. McDermid Rock (A.P. Brown 3615)	*Eremophila hamulata* Buirchell & A.P.Br.	P1	Taxon formally published. See Buirchell & Brown (2016).
Eremophila sp. Mt Methwin (B. Backhouse et al. BEMJ 74)	*Eremophila laccata* Buirchell & A.P.Br.	P1	Taxon formally published. See Buirchell & Brown (2016).
Eremophila sp. Nooloo break-away (R.J. Dadd 27)	*Eremophila resiliens* Buirchell & A.P.Br.	P1	Taxon formally published. See Buirchell & Brown (2016).
Eremophila sp. Princess Ranges (M. Greeve 38)	*Eremophila regia* Buirchell & A.P.Br.	P1	Taxon formally published. See Buirchell & Brown (2016).
Eremophila sp. Tallering (J.D. Start & M.J. Greeve D 516)	*Eremophila ferricola* Buirchell & A.P.Br.	P1	Taxon formally published. See Buirchell & Brown (2016).
Eremophila sp. Wanna (M.J. Greeve & J.D. Start D7 44)	*Eremophila scrobiculata* Buirchell & A.P.Br.	P1	Taxon formally published. See Buirchell & Brown (2016).
Eremophila sp. Yinnetharra (J.D. Start D7 45)	*Eremophila yinnetharrensis* Buirchell & A.P.Br.	P1	Taxon formally published. See Buirchell & Brown (2016).
Eremophila sp. Young Range (Desert Dreaming Expedition 93)	*Eremophila jamesiorum* Buirchell & A.P.Br.	P2	Taxon formally published. See Buirchell & Brown (2016).
Eriachne sp. Dampier Peninsula (K.F. Kenneally 5946)	*Eriachne pindanica* R.L.Barrett		Taxon formally published. See Barrett (2016).
Eriocaulon sp. C Kimberley Flora (G.J. Keighery 4610)	*Eriocaulon pygmaeum* Sm.		Name synonymised. See Leach (2017).
Eriocaulon sp. G Kimberley Flora (K.F. Kenneally 11374E)	*Eriocaulon cinereum* R.Br.		Name synonymised. See Leach (2017).
Eriocaulon sp. Theda (M.D. Barrett MDB 2063)	*Eriocaulon tortuosum* F.Muell.		Name synonymised. M.D. Barrett *in sched.* (10/04/2015).
Eucalyptus clelandii (Maiden) Maiden	*Eucalyptus clelandiorum* (Maiden) Maiden		Orthographic variant. See CHAH (2006).

Old Name	New Name	Status	Comments
Eucalyptus kingsmillii subsp. *alatissima* Brooker & Hopper	*Eucalyptus alatissima* (Brooker & Hopper) D.Nicolle		Nomenclatural synonym. See Nicolle (2013).
Eucalyptus kingsmillii (Maiden) Maiden & Blakely subsp. *kingsmillii*	*Eucalyptus kingsmillii* (Maiden) Maiden & Blakely		Nomenclatural synonym. No subspecies recognised. See Nicolle (2013).
Euryomyrtus sp. Parker Range (N. Gibson & M. Lyons 2269)	*Rinzia medifila* Rye & Trudgen	P1	Taxon formally published. See Rye (2017a).
Galenia pubescens (Eckl. & Zeyh.) Druce	*Aizoon pubescens* Eckl. & Zeyh.	*	Nomenclatural synonym. See Klak *et al.* (2017).
Galenia pubescens (Eckl. & Zeyh.) Druce var. *pubescens*	*Aizoon pubescens* Eckl. & Zeyh.	*	Nomenclatural synonym. See Klak *et al.* (2017).
Gmelina schlechteri H.J.Lam	*Gmelina australis* de Kok	P1	Misapplied name. See de Kok (2012).
Gnephosis eriocephala (A.Gray) Benth.	*Gnephosis brevifolia* (A.Gray) Benth.		Taxonomic synonym. See Short (2016).
Gnephosis intonsa S.Moore	*Notisia intonsa* (S.Moore) P.S.Short	P3	Nomenclatural synonym. See Short (2016).
Gnephosis sp. Billabong (B. Nordenstam & A. Anderberg 203)	*Gnephosis gynotricha* Diels		Name synonymised. See Short (2016).
Gnephosis sp. Norseman (K.R. Newbey 8096)	*Gnephosis brevifolia* (A.Gray) Benth.		Name synonymised. See Short (2016).
Gnephosis sp. Pt Quobba (P.G. Wilson 12622)	*Gnephosis tenuissima* Cass.		Name synonymised. See Short (2016).
Goodenia pumilio R.Br.	n/a	P3	Name made current. Taxon reinstated. M.D. Barrett *in litt.* (02/08/2016).
Grevillea thelemanniana subsp. Cooljarloo (B.J. Keighery 28 B)	*Grevillea* sp. Cooljarloo (B.J. Keighery 28 B)	P1	Name synonymised. P.M. Olde *in litt.* (17/08/2017).
Grevillea thelemanniana Endl. subsp. *thelemanniana*	*Grevillea thelemanniana* Endl.	T	Nomenclatural synonym. No subspecies recognised. P.M. Olde *in litt.* (17/08/2017).
Gyrostemon sp. Ravensthorpe (G. Cockerton & N. Evelegh 9467)	*Gyrostemon sessilis* A.S.George		Name synonymised. M. Hislop *in litt.* (28/01/2016).
Helichrysum luteoalbum (L.) Rchb.	*Pseudognaphalium luteoalbum* (L.) Hilliard & B.L.Burtt		Nomenclatural synonym. See Nie *et al.* (2013).
Hemigenia glabrescens Benth.	*Hemigenia humilis* Benth.		Taxonomic synonym. See CHAH (2014).
Hibbertia pachyrrhiza Steud.	*Hibbertia huegelii* (Endl.) F.Muell.		Taxonomic synonym. See Thiele (2017b).
Hibbertia recurvifolia (Steud.) Benth.	*Hibbertia lineata* Steud.		Taxonomic synonym. See Thiele (2017a).
Hibbertia sp. Fitzgerald River (D.A. Rathbone DAR 622)	*Hibbertia verrucosa* (Turcz.) Benth.		Name synonymised. See Thiele (2017a).
Hibbertia sp. Kojonup (C.M. Lewis 288)	*Hibbertia microphylla* Steud.		Name synonymised. See Thiele (2017a).
Hibbertia sp. Tenterden (M. Sowry 154)	*Hibbertia sejuncta* K.R.Thiele & Nge	P2	Taxon formally published. See Thiele & Nge (2017).
Hibiscus sp. Canga (P.J.H. Hurter & J. Naaykens 11013)	*Hibiscus campanulatus* A.J.Perkins	P1	Taxon formally published. See Perkins (2017b).

Old Name	New Name	Status	Comments
Hibiscus sp. Theda (M.D. Barrett & R.L. Barrett MDB 2144)	*Hibiscus kirstyae* Craven	P1	Taxon formally published. See Craven *et al.* (2016).
Hyptis suaveolens (L.) Poit.	*Mesosphaerum suaveolens* (L.) Kuntze	*	Nomenclatural synonym. See Harley & Pastore (2012).
Ipomoea sp. Napier Range (R.L. Barrett et al. RLB 2186 A)	*Ipomoea johnsoniana* R.L.Barrett	P1	Taxon formally published. See Barrett (2016).
Isolepis humillima (Benth.) K.L.Wilson	*Schoenoplectiella humillima* (Benth.) Shiels, Glon & Monfils	P2	Nomenclatural synonym. See Glon *et al.* (2017).
Isopogon heterophyllus Meisn.	*Isopogon formosus* R.Br. subsp. *formosus*		Taxonomic synonym. See Rye & Hislop (2017).
Isopogon teretifolius subsp. *petrophiloides* (R.Br.) Foreman	*Isopogon teretifolius* R.Br.		Taxonomic synonym. See Rye & Hislop (2017).
Isopogon teretifolius R.Br. subsp. *teretifolius*	*Isopogon teretifolius* R.Br.		Nomenclatural synonym. No subspecies recognised. See Rye & Hislop (2017).
Lasiopetalum sp. Mount Caroline (S.D. Hopper SDH 6381)	*Lasiopetalum moullean* K.A.Sheph. & C.F.Wilkins	T	Taxon formally published. See Shepherd & Wilkins (2017).
Lasiopetalum sp. Mount Lesueur (E.A. Griffin 1997)	*Lasiopetalum rutilans* K.A.Sheph. & C.F.Wilkins	P2	Taxon formally published. See Shepherd & Wilkins (2017).
Lasiopetalum sp. Toodyay (F. Hort 2689)	*Lasiopetalum caroliae* K.A.Sheph.	P3	Taxon formally published. See Shepherd & Wilkins (2017).
Lechenaultia divaricata F.Muell.	n/a		Excluded taxon. M. Hislop *in sched.* (25/05/2017).
Lepidosperma viscidum R.Br.	n/a		Excluded taxon. See Barrett & Wilson (2012).
Leptochloa fusca (L.) Kunth	*Diplachne fusca* (L.) Roem. & Schult.		Nomenclatural synonym. See Peterson *et al.* (2012).
Leptochloa fusca (L.) Kunth. subsp. *fusca*	*Diplachne fusca* (L.) Roem. & Schult. subsp. *fusca*		Nomenclatural synonym. See Peterson *et al.* (2012).
Leptochloa fusca subsp. *muelleri* (Benth.) N.Snow	*Diplachne fusca* subsp. *muelleri* (Benth.) P.M.Peterson & N.Snow		Nomenclatural synonym. See Peterson *et al.* (2012).
Leptochloa fusca subsp. *uninervia* (J.Presl) N.Snow	*Diplachne fusca* subsp. *uninervia* (J.Presl) P.M.Peterson & N.Snow	*	Nomenclatural synonym. See Peterson *et al.* (2012).
Leptochloa neesii (Thwaites) Benth.	*Dinebra neesii* (Thwaites) P.M.Peterson & N.Snow		Nomenclatural synonym. See Peterson *et al.* (2012).
Leucopogon sp. Arrowsmith (M. Hislop 2509)	*Leucopogon inflexus* Hislop		Taxon formally published. See Hislop (2016a).
Leucopogon sp. Bifid Eneabba (M. Hislop 1927)	*Styphelia filamentosa* Hislop & Puente-Lel.	P3	Taxon formally published. See Hislop & Puente-Lelièvre (2017).
Leucopogon sp. Burma Road (M. Hislop 2032)	*Leucopogon grammatus* Hislop	P3	Taxon formally published. See Hislop (2016a).
Leucopogon sp. Cataby (F. Hort 1638)	*Leucopogon foliosus* Hislop	P3	Taxon formally published. See Hislop (2016a).
Leucopogon sp. ciliate Eneabba (F. Obbens & C. Godden s.n. 3/7/2003)	*Styphelia longissima* Hislop & Puente-Lel.	T	Taxon formally published. See Hislop & Puente-Lelièvre (2017).
Leucopogon sp. Lesueur (B. Evans 530)	*Leucopogon stenophyllus* Hislop		Taxon formally published. See Hislop (2016a).

Old Name	New Name	Status	Comments
Leucopogon sp. Moore River (M. Hislop 1695)	*Styphelia ciliosa* Hislop & Puente-Lel.		Taxon formally published. See Hislop & Puente-Lelièvre (2017).
Leucopogon sp. Murdoch (M. Hislop 1037)	*Styphelia filifolia* Hislop & Puente-Lel.	P3	Taxon formally published. See Hislop & Puente-Lelièvre (2017).
Leucopogon sp. South Eneabba (E.A. Griffin 8027)	*Leucopogon prolatus* Hislop		Taxon formally published. See Hislop (2016a).
Leucopogon sp. Warradarge (M. Hislop 1908)	*Styphelia williamsiorum* Hislop & Puente-Lel.		Taxon formally published. See Hislop & Puente-Lelièvre (2017).
Leucopogon sp. Watheroo (R.D. Royce 9616)	*Leucopogon simulans* Hislop		Taxon formally published. See Hislop (2016a).
Mimulus clementii Domin	*Uvedalia clementii* (Domin) W.R.Barker & Beardsley	P1	Nomenclatural synonym. See Barker *et al.* (2012).
Mimulus prostratus Benth.	*Elacholoma prostrata* (Benth.) W.R.Barker & Beardsley		Nomenclatural synonym. See Barker *et al.* (2012).
Mimulus repens R.Br.	*Thyridia repens* (R.Br.) W.R.Barker & Beardsley		Nomenclatural synonym. See Barker *et al.* (2012).
Mimulus uvedaliae Benth.	*Uvedalia linearis* R.Br.		Taxonomic synonym. See Barker *et al.* (2012).
Mimulus uvedaliae var. *lutea* Benth.	*Uvedalia linearis* var. *lutea* (Benth.) W.R.Barker & Beardsley		Nomenclatural synonym. See Barker *et al.* (2012).
Mimulus uvedaliae Benth. var. *uvedaliae*	*Uvedalia linearis* R.Br. var. *linearis*		Taxonomic synonym. See Barker *et al.* (2012).
Mollugo cerviana (L.) Ser.	*Hypertelis cerviana* (L.) Thulin		Nomenclatural synonym. See Thulin *et al.* (2016).
Mollugo molluginea (F.Muell.) Druce	*Trigastrotheca molluginea* F.Muell.		Nomenclatural synonym. See Thulin *et al.* (2016).
Myriophyllum callitrichoides Orchard subsp. *callitrichoides*	*Myriophyllum callitrichoides* Orchard		Nomenclatural synonym. No subspecies recognised. See Barrett *et al.* (2016).
Myriophyllum callitrichoides subsp. *striatum* Orchard	*Myriophyllum striatocarpum* M.D.Barrett, M.L.Moody & R.L.Barrett	P2	Nomenclatural synonym. See Barrett *et al.* (2016).
Myriophyllum sp. Harding Range (M.D. Barrett & R.L. Barrett MDB 1825)	*Myriophyllum foveicola* M.D.Barrett, M.L.Moody & R.L.Barrett	P3	Taxon formally published. See Barrett *et al.* (2016).
Phyllanthus rhytidospermus Müll.Arg.	*Synostemon rhytidospermus* (Müll.Arg.) I.Telford & Pruesapan		Nomenclatural synonym. See Telford *et al.* (2016).
Pimelea longiflora subsp. *eyrei* (F.Muell.) Rye	*Pimelea eyrei* F.Muell.	P2	Nomenclatural synonym. See Foster *et al.* (2016).
Pimelea longiflora R.Br. subsp. *longiflora*	*Pimelea longiflora* R.Br.		Nomenclatural synonym. No subspecies recognised. See Foster *et al.* (2016).
Platysace teres (Bunge) C.Norman	n/a		Name made current. Taxon reinstated. M. Hislop *in litt.* (09/10/2017).
Polycarpaea sp. A Kimberley Flora (K.F. Kenneally 8887)	*Polycarpaea umbrosa* R.L.Barrett	P1	Taxon formally published. See Barrett (2016).
Prasophyllum sp. Swan Region (G.B. Brockman 1082)	*Prasophyllum cuneatum* D.L.Jones & G.Brockman		Name synonymised. See Jones & Brockman (2016).

Old Name	New Name	Status	Comments
Pterostylis sp. dainty brown (N. Gibson & M. Lyons 3690)	*Pterostylis tryphera* (D.L.Jones & C.J.French) D.L.Jones & C.J.French		Name synonymised. G. Brockman & C.J. French *in sched.* (15/11/2017).
Pterostylis sp. late flowering (W. Jackson BJ298)	*Pterostylis glebosa* D.L.Jones & C.J.French		Name synonymised. G.B. Brockman & C.J. French *in sched.* (22/11/2017).
Pterostylis sp. laterite (D.L. Jones 3081 & M.A. Clements)	*Pterostylis tryphera* (D.L.Jones & C.J.French) D.L.Jones & C.J.French		Name synonymised. G. Brockman & C.J. French *in sched.* (15/11/2017).
Ptilotus brachyanthus (Benth.) F.Muell.	n/a		Excluded taxon. See Bean (2008).
Ptilotus gomphrenoides var. *conglomeratus* (Farmar) Benl	*Ptilotus gomphrenoides* Benth.		Taxonomic synonym. See Hammer & Davis (2017).
Ptilotus gomphrenoides Benth. var. *gomphrenoides*	*Ptilotus gomphrenoides* Benth.		Nomenclatural synonym. No varieties recognised. See Hammer & Davis (2017).
Ptilotus gomphrenoides var. *roseo-albus* (Farmar) Benl	*Ptilotus gomphrenoides* Benth.		Taxonomic synonym. See Hammer & Davis (2017).
Ptilotus pseudohelipteroides Benl	n/a		Excluded taxon. R. Davis & T. Hammer *in litt.* (16/10/2017).
Ptilotus sp. Kennedy Range (A.P. Brown 4276)	*Ptilotus polakii* F.Muell. subsp. *polakii*		Name synonymised. See Hammer & Davis (2017).
Ptilotus sp. Northampton (R. Davis 10952)	*Ptilotus benlii* R.W.Davis & T.Hammer		Taxon formally published. See Davis & Hammer (2017).
Rinzia morrisonii Trudgen	*Rinzia longifolia* Turcz.	P3	Taxonomic synonym. See Rye (2017a).
Rinzia sp. Darling Range (F. Hort 2040)	*Rinzia crassifolia* Turcz.		Name synonymised. See Rye (2017a).
Sarcocornia blackiana (Ulbr.) A.J.Scott	*Salicornia blackiana* Ulbr.		Nomenclatural synonym. See Piirainen *et al.* (2017).
Sarcocornia globosa Paul G.Wilson	*Salicornia globosa* (Paul G.Wilson) Piirainen & G.Kadereit	P3	Nomenclatural synonym. See Piirainen *et al.* (2017).
Sarcocornia quinqueflora (Ung.-Sternb.) A.J.Scott	*Salicornia quinqueflora* Ung.-Sternb.		Nomenclatural synonym. See Piirainen *et al.* (2017).
Sarcocornia quinqueflora (Ung.-Sternb.) A.J.Scott subsp. *quinqueflora*	*Salicornia quinqueflora* Ung.-Sternb. subsp. *quinqueflora*		Nomenclatural synonym. See Piirainen *et al.* (2017).
Sarcostemma brevipedicellatum P.I.Forst.	*Cynanchum brevipedicellatum* (P.I.Forst.) Liede & Meve		Nomenclatural synonym. See Meve & Liede-Schumann (2012).
Sarcostemma esculentum (L.f.) R.W.Holm	*Oxystelma esculentum* (L.f.) Schult.		Nomenclatural synonym. See Liede & Täuber (2000).
Sarcostemma viminale (L.) R.Br.	*Cynanchum viminale* (L.) Bassi		Nomenclatural synonym. See Meve & Liede-Schumann (2012).
Sarcostemma viminale subsp. *australe* (R.Br.) P.I.Forst.	*Cynanchum viminale* subsp. *australe* (R.Br.) Meve & Liede		Nomenclatural synonym. See Meve & Liede-Schumann (2012).
Sarcostemma viminale subsp. *brunonianum* (Wight & Arn.) P.I.Forst.	*Cynanchum viminale* subsp. *brunonianum* (Wight & Arn.) Meve & Liede		Nomenclatural synonym. See Meve & Liede-Schumann (2012).
Sauropus hubbardii Airy Shaw	*Synostemon hubbardii* (Airy Shaw) I.Telford & Pruesapan	P3	Nomenclatural synonym. See Telford *et al.* (2016).

Old Name	New Name	Status	Comments
Sauropus lissocarpus (S.Moore) Airy Shaw	*Synostemon lissocarpus* (S.Moore) I.Telford & Pruesapan		Nomenclatural synonym. See Telford *et al.* (2016).
Sauropus salignus J.T.Hunter & J.J.Bruhl	*Synostemon salignus* (J.T.Hunter & J.J.Bruhl) I.Telford & Pruesapan	P1	Nomenclatural synonym. See Telford *et al.* (2016).
Sauropus sp. A Kimberley Flora (T.E.H. Aplin et al. 929)	*Synostemon judithae* I.Telford & J.J.Bruhl	P2	Taxon formally published. See Telford *et al.* (2016).
Sauropus sp. B Kimberley Flora (B.J. Carter 625)	*Synostemon salignus* (J.T.Hunter & J.J.Bruhl) I.Telford & Pruesapan	P1	Name synonymised. See Telford *et al.* (2016).
Schoenoplectus dissachanthus (S.T.Blake) J.Raynal	*Schoenoplectiella dissachantha* (S.T.Blake) Lye		Nomenclatural synonym. See Lye (2003).
Schoenoplectus laevis (S.T.Blake) J.Raynal	*Schoenoplectiella laevis* (S.T.Blake) Lye		Nomenclatural synonym. See Lye (2003).
Schoenoplectus lateriflorus (J.F.Gmel.) Lye	*Schoenoplectiella lateriflora* (J.F.Gmel.) Lye		Nomenclatural synonym. See Lye (2003).
Schoenoplectus mucronatus (L.) A.Kern.	*Schoenoplectiella mucronata* (L.) J.Jung & H.K.Choi		Nomenclatural synonym. See Jung & Choi (2010).
Schoenoplectus praelongatus (Poir.) J.Raynal	*Schoenoplectiella praelongata* (Poir.) Lye		Nomenclatural synonym. See Lye (2003).
Schoenoplectus validus (Vahl) Á.Löve & D.Löve	*Schoenoplectus tabernaemontani* (C.C.Gmel.) Palla		Taxonomic synonym. See Smith (1995).
Scholtzia leptantha Benth.	*Scholtzia obovata* (DC.) Schauer		Taxonomic synonym. See Rye (2017b).
Scholtzia sp. Kalbarri (N. Hoyle 623)	*Scholtzia oligandra* Benth.		Name synonymised. See Rye (2017b).
Sida sp. sand dunes (A.A. Mitchell PRP1208)	*Sida* sp. Western sand dunes (P.K. Latz 11980)		Name synonymised. R.M. Barker *in litt.* (02/05/2016).
Spartothamnella canescens K.R.Thiele & K.A.Sheph.	*Teucrium disjunctum* K.R.Thiele & K.A.Sheph.		Nomenclatural synonym. See Shepherd & Thiele (2017).
Stylidium adnatum var. *abbreviatum* Benth.	*Stylidium adnatum* R.Br.		Taxonomic synonym. See Wege (2017b).
Stylidium adnatum R.Br. var. *adnatum*	*Stylidium adnatum* R.Br.		Nomenclatural synonym. No varieties recognised. See Wege (2017b).
Stylidium sp. Banovich Road (F. & J. Hort 1884)	*Stylidium strigosum* Lowrie & Kenneally	P1	Taxon formally published. See Lowrie & Kenneally (2017).
Stylidium sp. Bindoon (K.F. Kenneally 11405)	*Stylidium bindoon* Lowrie & Kenneally		Taxon formally published. See Lowrie & Kenneally (2017).
Stylidium sp. Bluff Knoll (S. Barrett s.n. 8/11/1994)	*Stylidium monticola* Lowrie & Kenneally	P2	Taxon formally published. See Lowrie & Kenneally (2017).
Stylidium sp. Dewars Pool (K.F. Kenneally 11400)	*Stylidium vinosum* Lowrie & Kenneally	P1	Taxon formally published. See Lowrie & Kenneally (2017).
Stylidium sp. Glabrous inflorescence (R. Davis 7917)	*Stylidium nitidum* Lowrie & Kenneally	P1	Taxon formally published. See Lowrie & Kenneally (2017).
Stylidium sp. Kalbarri (A. Carr 145)	*Stylidium ponticulus* Lowrie & Kenneally		Taxon formally published. See Lowrie & Kenneally (2017).
Stylidium sp. Narembeen (W.E. Blackall s.n. /09/1929)	*Stylidium amphora* Lowrie & Kenneally		Taxon formally published. See Lowrie & Kenneally (2017).

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Tephrosia sp. O.T. Station (S.T. Blake 17659)	*Tephrosia* sp. Magazine Hill (P. Jones 365)		Name synonymised. R. Butcher *in litt.* (14/04/2017).
Tetratheca sp. Boonanarring (F. Hort 1509)	*Tetratheca hirsuta* subsp. *boonanarring* Joyce & R.Butcher	P2	Taxon formally published. See Joyce *et al.* (2017).
Tetratheca sp. Granite (S. Patrick SP1224)	*Tetratheca hirsuta* Lindl. subsp. *hirsuta*		Name synonymised. See Joyce *et al.* (2017).
Tetratheca viminea Lindl.	*Tetratheca hirsuta* subsp. *viminea* (Lindl.) Joyce		Nomenclatural synonym. See Joyce *et al.* (2017).
Thecanthes concreta (F.Muell.) Rye	*Pimelea concreta* F.Muell.		Nomenclatural synonym. See Foster *et al.* (2016).
Thecanthes punicea (R.Br.) Wikstr.	*Pimelea punicea* R.Br.		Nomenclatural synonym. See Foster *et al.* (2016).
Thecanthes sanguinea (F.Muell.) Rye	*Pimelea sanguinea* F.Muell.		Nomenclatural synonym. See Foster *et al.* (2016).
Triodia sp. Little Sandy Desert (S. van Leeuwen 4935)	*Triodia birriliburu* B.M.Anderson	P3	Taxon formally published. See Anderson *et al.* (2017).
Triodia sp. Pannawonica (B.M. Anderson & M.D. Barrett BMA 89)	*Triodia mallota* B.M.Anderson & M.D.Barrett	P1	Taxon formally published. See Anderson *et al.* (2017).
Triodia sp. Peedamulla (A.A. Mitchell PRP 1636)	*Triodia glabra* B.M.Anderson & M.D.Barrett		Taxon formally published. See Anderson *et al.* (2017).
Triodia sp. Shovelanna Hill (S. van Leeuwen 3835)	*Triodia vanleeuwenii* B.M.Anderson & M.D.Barrett		Taxon formally published. See Anderson *et al.* (2017).
Triodia sp. Warrawagine (A.L. Payne PRP 1859)	*Triodia scintillans* B.M.Anderson & M.D.Barrett		Taxon formally published. See Anderson *et al.* (2017).
Tripogon loliiformis (F.Muell.) C.E.Hubb.	*Tripogonella loliiformis* (F.Muell.) P.M.Peterson & Romasch.		Nomenclatural synonym. See Peterson *et al.* (2016).
Xerochrysum bracteatum (Vent.) Tzvelev	n/a		Excluded taxon. See Wilson (2017).

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References

Anderson, B.M., Thiele, K.R. & Barrett, M.D. (2017). A revision of the *Triodia basedowii* species complex and close relatives (Poaceae: Chloridoideae). *Australian Systematic Botany* 30: 197–229.

Angiosperm Phylogeny Group (2016). An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. *Botanical Journal of the Linnean Society* 181: 1–20.

Barker, W.R. (2005). Standardising informal names in Australian publications. *Australian Systematic Botany Society Newsletter* 122: 11–12.

Barker, W.R., Nesom, G.L., Beardsley, P.M. & Fraga, N.S. (2012). A taxonomic conspectus of Phrymaceae: A narrowed circumscription for *Mimulus*, new and resurrected genera, and new names and combinations. *Phytoneuron* 39: 1–60.

Barrett, M.D., Moody, M. & Barrett, R.L. (2016). A review of *Myriophyllum callitrichoides* (Haloragaceae) in Western Australia. *Telopea* 19: 207–211.

Barrett, R.L. (2016). Three new species from the Kimberley region of Western Australia from the families Caryophyllaceae, Convolvulaceae and Poaceae. *Nuytsia* 27: 287–298.

Barrett, R.L. & Wilson, K.L. (2012). A review of the genus *Lepidosperma* Labill. (Cyperaceae: Schoeneae). *Australian Systematic Botany* 25: 225–294.

Bean, A.R. (2008). A synopsis of *Ptilotus* (Amaranthaceae) in eastern Australia. *Telopea* 12: 227–250.

Buirchell, B.J. & Brown, A.P. (2016). New species of *Eremophila* (Scrophulariaceae): thirteen geographically restricted species from Western Australia. *Nuytsia* 27: 253–283.

CHAH (Council of Heads of Australasian Herbaria) (2006). *National Species List*. https://id.biodiversity.org.au/instance/apni/612712 [accessed 13 September 2016].

CHAH (Council of Heads of Australasian Herbaria) (2014). *National Species List*. https://id.biodiversity.org.au/instance/apni/781494 [accessed 9 October 2017].

CHAH (Council of Heads of Australasian Herbaria) (2016). *National Species List*. https://id.biodiversity.org.au/instance/apni/649659 [accessed 25 July 2017].

Craven, L.A., Barrett, R.L. & Barrett, M.D. (2016). Three new species and one new combination in *Hibiscus* (Malvaceae). *Muelleria* 35: 3–14.

Crisp, M.D., Cayzer, L., Chandler, G.R. & Cook, L.G. (2017). A monograph of *Daviesia* (Mirbelieae, Faboideae, Fabaceae). *Phytotaxa* 300: 1–308.

Davis, R.W. & Brown, A.P. (2017). A new species of *Chamaescilla* (Asparagaceae) from the mid-west of Western Australia. *Nuytsia* 28: 225–227.

Davis, R.W. & Hammer, T.A. (2017). *Ptilotus benlii* (Amaranthaceae), a new species from Western Australia. *Nuytsia* 28: 299–302.

Davis, R.W., Hammer, T.A. & Thiele, K.R. (2016). A new and rare species of *Nymphoides* (Menyanthaceae) from the North West of Western Australia. *Nuytsia* 27: 245–252.

Dimon, R.J. & Renner, M.A.M. (2017). A new *Cynoglossum* species, and transfers to *Hackelia* in eastern Australian Boraginaceae. *Australian Systematic Botany* 30: 113–123.

Fici, S. (2015). A taxonomic revision of the *Capparis spinosa* group (Capparaceae) from eastern Africa to Oceania. *Phytotaxa* 203: 24–36.

Foster, C.S.P., Cantrill, D.J., James, E.A., Syme, A.E., Jordan, R., Douglas, R., Ho, S.Y.W. & Henwood, M.J. (2016). Molecular phylogenetics provides new insights into the systematics of *Pimelea* and *Thecanthes* (Thymelaeaceae). *Australian Systematic Botany* 29: 185–196.

Glon, H.E., Shiels, D.R., Linton, E., Starr, J.R., Shorkey, A.L., Fleming, S., Lichtenwald, S.K., Schick, E.R., Pozo, D. & Mofils, A.K. (2017). A Five Gene Phylogenetic Study of Fuireneae (Cyperaceae) with a Revision of *Isolepis humillima*. *Systematic Botany* 42: 26–36.

Hammer, T.A. & Davis, R.W. (2017). Synonymisation of three Western Australian taxa within *Ptilotus* (Amaranthaceae). *Nuytsia* 28: 133–134.

Harley, R.M. & Pastore, J.F.B. (2012). A generic revision and new combinations in the Hyptidinae (Lamiaceae), based on molecular and morphological evidence. *Phytotaxa* 58: 1–55.

Harrington, M.G. & Gadek, P.A. (2010). Phylogenetics of hopbushes and pepperflowers (*Dodonaea*, *Diplopeltis* - Sapindaceae), based on nuclear ribosomal ITS and partial ETS sequences incorporating secondary-structure models. *Australian Systematic Botany* 23: 431–442.

Hayasaka, E. (2012). Delineation of *Schoenoplectiella* Lye (Cyperaceae), a genus newly segregated from *Schoenoplectus* (Rchb.) Palla. *Journal of Japanese Botany* 87: 169–186.

Hislop, M. (2016a). New species of *Leucopogon s. str.* (Ericaceae: Epacridoideae: Styphelieae) from the Geraldton Sandplains. *Nuytsia* 27: 217–242.

Hislop, M. (2016b). *Stenanthera pungens* (Ericaceae: Epacridoideae: Styphelieae), a new combination, and a new genus for Western Australia. *Nuytsia* 27: 285–286.

Hislop, M. & Cranfield, R.J. (2017). A taxonomic update of *Brachyloma* (Ericaceae: Epacridoideae: Styphelieae) in Western Australia. *Nuytsia* 28: 303–316.

Hislop, M. & Puente-Lelièvre, C. (2017). Five new species of *Styphelia* (Ericaceae: Epacridoideae: Styphelieae) from the Geraldton Sandplains, including notes on a new, expanded circumscription for the genus. *Nuytsia* 28: 95–114.

Hopper, S.D., Purdie, R.W., George, A.S. & Patrick, S.J. (1987). *Conostylis*. *In*: George, A.S. (ed.). *Flora of Australia*. Vol. 45: Hydatellaceae to Liliaceae. pp. 57–110. (Australian Biological Resources Study: Canberra / CSIRO Publishing: Melbourne.)

Jackes, B.R. (2017). A revision of *Dolichandrone* (Bignoniaceae) in Australia. *Australian Systematic Botany* 30: 26–37.

Jones, D.L. & Brockman, G. (2016). *Prasophyllum cuneatum* (Orchidaceae), a new species from Western Australia. *Australian Orchid Review* 81(6): 50–52.

Jones, D.L. & French, C.J. (2016). Three new species in the *Diuris corymbosa* Lindley complex (Orchidaceae) from Western Australia. *Australian Orchid Review* 81(4): 27–39.

Jones, D.L. & French, C.J. (2017). New combinations in *Pterostylis* and *Corunastylis* (Orchidaceae). *Australian Orchid Review* 82(3): 63.

Joyce, E.M., Butcher, R., Byrne, M., Grierson, P.F., Hankinson, M. & Thiele, K.R. (2017). Taxonomic resolution of the *Tetratheca hirsuta* (Elaeocarpaceae) species complex using an integrative approach. *Australian Systematic Botany* 30: 1–25.

Jung, J. & Choi, H.L. (2010). Systematic rearrangement of Korean *Scirpus* L. *s.l.* (Cyperaceae) as inferred from nuclear ITS and chloroplast rbcL sequences. *Journal of Plant Biology* 53: 222–232.

Klak, C., Hanáček, P. & Bruyns, P.V. (2017). Disentangling the Aizooideae: New generic concepts and a new subfamily in Aizoaceae. *Taxon* 66: 1147–1170.

Kok, R. de (2012). A revision of the genus *Gmelina* (Lamiaceae). *Kew Bulletin* 67: 293–329.

Lang, P.J. & Davies, R.J.-P. (2017). *Goodenia asteriscus* (Goodeniaceae), a new arid zone species from north-western South Australia and eastern Western Australia. *Swainsona* 31: 37–43.

Leach, G.J. (2017). A revision of Australian *Eriocaulon* (Eriocaulaceae). *Telopea* 20: 205–259.

Lehtonen, S. (2017). Splitting *Caldesia* in favour of *Albidella* (Alismataceae). *Australian Systematic Botany* 30: 64–69.

Liede, S. & Täuber, A. (2000). *Sarcostemma* R.Br. (Apocynaceae—Asclepiadoideae)—a controversial generic circumscription reconsidered: Evidence from *trn*L-F spacers. *Plant Systematics and Evolution* 225: 133–140.

Lohr, M.T. & Keighery, G. (2016). *Quercus* (Fagaceae) in Western Australia. *Western Australian Naturalist* 30: 172–175.

Lowrie, A. (2014). *Carnivorous plants of Australia magnum opus*. Vol. 3. (Redfern Natural History Productions: Poole, United Kingdom.)

Lowrie, A. & Kenneally, K.F. (2017). A taxonomic revision of the basin-like rosetted triggerplants of the *Stylidium piliferum* complex (Stylidiaceae) from south-western Australia. *Nuytsia* 28: 339–382.

Lye, K.A. (2003). *Schoenoplectiella* Lye, gen. nov. (Cyperaceae). *Lidia* 6: 20–29.

Meve, U. & Liede-Schumann, S. (2012). Taxonomic dissolution of *Sarcostemma* (Apocynaceae: Asclepiadoideae). *Kew Bulletin* 67: 751–758.

Nge, F.J., Keighery, G.J. & Thiele, K.R. (2017). A revision of the *Calytrix acutifolia* complex (Myrtaceae: Chamelaucieae). *Nuytsia* 28: 321–337.

Nicolle, D. (2013). *Native eucalypts of South Australia*. (Dean Nicolle: Adelaide.)

Nie, Z.L., Funk, V., Sun, H., Deng, T., Meng, Y. & Wen, J. (2013). Molecular phylogeny of *Anaphalis* (Asteraceae, Gnaphalieae) with biogeographic implications in the Northern Hemisphere. *Journal of Plant Research* 126: 17–32.

Nightingale, M.E., Lazarides, M. & Weiller, C.M. (2005). *Brachyachne*. *In*: Mallett, K. (ed.) *Flora of Australia*. Vol. 44B: Poaceae 3. pp. 294–300. (Australian Biological Resources Study: Canberra / CSIRO Publishing: Melbourne.)

Obbens, F.J., Hancock, L.P., Edwards, E. & Thiele, K.R. (2017). *Calandrinia holtumii* (Portulacaceae), a new and unusual species from arid Western Australia. *Nuytsia* 28: 217–223.

Perkins, A.J. (2017a). Rising from the ashes - *Hydrocotyle phoenix* (Araliaceae), a new annual species from south-western Australia. *Telopea* 20: 41–47.

Perkins, A.J. (2017b). *Hibiscus campanulatus* (Malvaceae), a new and rare species from the Pilbara bioregion, Western Australia. *Nuytsia* 28: 135–138.

Perkins, A.J. & Dilly, M.L. (2017). *Hydrocotyle serendipita* (Araliaceae), a new species of fire ephemeral from south-western Australia. *Telopea* 20: 269–275.

Peterson, P.M., Romaschenko, K. & Herrera Arrieta, Y. (2016). A molecular phylogeny and classification of the Cynodonteae (Poaceae: Chloridoideae) with four new genera: *Orthacanthus*, *Triplasiella*, *Tripogonella*, and *Zaqiqah*; three new subtribes: Dactylocteniinae, Orininae, and Zaqiqahinae; and a subgeneric classification of *Distichlis*. *Taxon* 65: 1263–1287.

Peterson, P.M., Romaschenko, K., Snow, N. & Johnson, G. (2012). A molecular phylogeny and classification of *Leptochloa* (Poaceae: Chloridoideae: Chlorideae) sensu lato and related genera. *Annals of Botany (Oxford) new series* 109: 1317–1330.

Piirainen, M., Liebisch, O. & Kadereit, G. (2017). Phylogeny, biogeography, systematics and taxonomy of Salicornioideae (Amaranthaceae/Chenopodiaceae) – A cosmopolitan, highly specialized hygrohalophyte lineage dating back to the Oligocene. *Taxon* 66: 109–132.

Rye, B.L. (2013). A revision of the south-western Australian genus *Astartea* (Myrtaceae: Chamelaucieae). *Nuytsia* 23: 189–269.

Rye, B.L. (2017a). An expanded circumscription and new infrageneric classification of *Rinzia* (Myrtaceae: Chamelaucieae). *Nuytsia* 28: 39–93.

Rye, B.L. (2017b). New lectotypes and synonyms in the Western Australian genus *Scholtzia* (Myrtaceae: Chamelaucieae). *Nuytsia* 28: 159–167.

Rye, B.L. (2017c). Revision of the south-western Australian genus *Anticoryne* (Myrtaceae: Chamelaucieae). *Nuytsia* 28: 205–215.

Rye, B.L. & Hislop, M. (2017). Two new synonyms in Western Australian Proteaceae: *Isopogon heterophyllus* and *I. teretifolius* subsp. *petrophiloides*. *Nuytsia* 28: 169–172.

Shaw, J.M.H. in Royal Horticultural Society (2014). Quarterly supplement to the international register and checklist of orchid hybrids (Sander's list): October–December 2013 registrations. *Orchid Review Supplement* 122(1305): 16.

Shepherd, K.A. & Thiele, K.R. (2017). *Teucrium disjunctum*, a new name for *Spartothamnella canescens* (Lamiaceae). *Nuytsia* 28: 139–140.

Shepherd, K.A. & Wilkins, C.F. (2017). A revision of the *Lasiopetalum floribundum* group (Malvaceae), including recognition of four new species. *Nuytsia* 28: 273–298.

Short, P.S. (2016). Notes concerning the classification of species included in *Calocephalus* R.Br. *s.lat.* and *Gnephosis* Cass. *s.lat.* (Asteraceae: Gnaphalieae), with descriptions of new genera and species. *Journal of the Adelaide Botanic Gardens* 29: 147–220.

Smith, M. (2017). *Threatened and Priority Flora list 8 March 2017*. Department of Parks and Wildlife https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 23 January 2018].

Smith, S.G. (1995). New Combinations in North American *Schoenoplectus*, *Bolboschoenus*, *Isolepis*, and *Trichophorum* (Cyperaceae). *Novon* 5: 97–102.

Telford, I.R.H., Pruesapan, K., Welzen, P.C. van & Bruhl, J.J. (2016). Morphological and molecular data show *Synostemon trachyspermus* (Phyllanthaceae, Phyllantheae) to be a heterogeneous species assemblage. *Australian Systematic Botany* 29: 218–234.

Testoni, D. & Villamil, C.B. (2014). Estudios en el género *Cortaderia* (Poaceae). I. Sistemática y nomenclatura de la sect. *Cortaderia*. *Darwiniana n.s.* 2: 260–276.

Thiele, K.R. (2017a). A revision of the *Hibbertia lineata* (Dilleniaceae) species group. *Nuytsia* 28: 173–191.

Thiele, K.R. (2017b). *Hibbertia striata*, a new combination for a long-overlooked Western Australian species, and inclusion of *H. pachyrrhiza* in *H. huegelii*. *Nuytsia* 28: 247–253.

Thiele, K.R. & Nge, F. (2017). *Hibbertia sejuncta*, a new, rare species from Western Australia, with notes on *H. helianthemoides*. *Nuytsia* 28: 115–117.

Thulin, M., Moore, A.J., El-Seedi, H., Larsson, A., Christin, P.-A. & Edwards, E.J. (2016). Phylogeny and generic delimitation in Molluginaceae, new pigment data in Caryophyllales, and the new family Corbichoniaceae. *Taxon* 65: 775–793.

Wannan, B.S. (2016). Three new species in *Lindernia* All. *s.l.* (Linderniaceae) for Australia. *Austrobaileya* 9: 508–523.

Wege, J.A. (2017a). Taxonomic notes on *Asterolasia* (Rutaceae) in Western Australia to inform conservation. *Nuytsia* 28: 141–146.

Wege, J.A. (2017b). *Stylidium* miscellany 3: a synopsis of Robert Brown's Stylidiaceae types and occasional notes on associated names. *Nuytsia* 28: 229–246.

Western Australian Herbarium (1998–). *FloraBase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. https:// florabase.dpaw.wa.gov.au/ [accessed 25 January 2017].

Wilson, P.G. (2017). An examination of the Australian genus *Xerochrysum* (Asteraceae: Gnaphalieae). *Nuytsia* 28: 11–38.

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SHORT COMMUNICATION

Eremophila subangustifolia (Scrophulariaceae), a rare new species from the Mid West Region of Western Australia, with notes on *E. microtheca*

Eremophila microtheca (F.Muell. ex Benth.) F.Muell. was described as a species of *Pholidia* R.Br. by George Bentham in 1870 based on specimens collected at Port Gregory and the Murchison River by Augustus Oldfield, and was later placed in *Eremophila* R.Br. by Ferdinand von Mueller (1882). The species no longer appears to occur in the Port Gregory area (probably due to the clearing of its habitat) but is still known from populations east of Kalbarri. We have examined a photograph of the type of *E. microtheca* and consider the Kalbarri populations to be a good match for this species.

Populations of plants determined to be a southern form of *E. microtheca* were subsequently found some 250 km to the south of Kalbarri near Eneabba. These plants differ in morphology from the type and were alluded to by Chinnock (2007) when he stated 'The Kalbarri population differs from more southern ones in having flattened leaves'.

In order to further ascertain the relationships of the two forms, a molecular study was conducted in 2013 using nine microsatellite markers. This study showed plants in the Eneabba populations to be genetically divergent from those found east of Kalbarri (Llorens *et al.* 2015). Plants in these two areas shared few alleles with one another and showed very high and significant values for measures of genetic differentiation (F_{ST} = 0.301 and 0.383; D_{est} = 0.756 and 0.774; $P < 0.001$). Several other statistical methods, including Bayesian STRUCTURE analysis, analysis of molecular variance (AMOVA), neighbour joining and principal coordinate analysis (PCoA), supported these results in showing a clear and significant divergence among plants from the two areas. Notably, the levels of differentiation among the Eneabba and Kalbarri populations were very similar to those obtained for interspecific comparisons between populations of *E. microtheca* and *E. lehmanniana* (Sonder) Chinnock, a closely allied species according to Chinnock (2007).

In recognising its distinctiveness, the Eneabba taxon was provided the phrase name *E. microtheca* subsp. narrow leaves (J.D.Start D12-150) by the Western Australian Herbarium in 2013 and, because of its narrow distribution, highly threatened habitat (flooding and rising salinity) and low number of extant plants, was subsequently listed as Threatened Flora under the provisions of the Western Australian *Wildlife Conservation Act* 1950.

Additional field and herbarium studies were undertaken by one of us (Andrew Brown) between 2013 and 2017, during which a number of additional morphological differences separating these taxa were noted. Consequently, we are now of the opinion the Eneabba taxon warrants recognition as a species rather than a subspecies and in March 2017 the Western Australian Herbarium erected the new phrase name *E.* sp. Narrow leaves (J.D. Start D12-150) to reflect this view.

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Eremophila subangustifolia A.P.Br. & Llorens, *sp. nov.*

Type: [near Eneabba] Western Australia [precise locality withheld for conservation reasons], 17 September 2013, *J.D. Start* D12-150 (*holo*: PERTH 08490910).

Eremophila microtheca subsp. narrow leaves (J.D.Start D12-150) ≡ *Eremophila* sp. Narrow leaves (J.D. Start D12-150), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed March 2017].

Illustrations. A.P. Brown & B.J. Buirchell, *A Field Guide to the Eremophilas of W. Austral.*, p. 185 (2011), top left and bottom right [as *E. microtheca*].

An erect to spreading, much-branched shrub, 1–2.5 m high, 2–4 m wide when mature, emitting a strong, slightly offensive odour. *Branches* grey, terete, non-tuberculate, young parts with dense, grey-white dendritic hairs, except for glabrous resinous bands extending down below leaf bases, old parts lacking hairs. *Leaves* green to grey-green, sessile, alternate, erect or spreading, scattered along branches; lamina linear-subterete, 6–17 mm long, 0.5–1 mm wide, the upper and lower surfaces with scattered, grey-white dendritic hairs; apex obtuse to subobtuse. *Flowers* 1 per axil; pedicel terete, straight or slightly curved, 5–7 mm long, with dense, grey-white dendritic hairs. *Sepals* 5, lanceolate, attenuate, imbricate, subequal, appressed against the corolla, 4–6 mm long, 0.8–1 mm wide, not enlarging after flowering; outer surface green with dense, grey-white dendritic hairs; inner surface green with dense grey-white dendritic hairs in the distal third, more sparsely hairy below except along margins. *Corolla* zygomorphic, 12–15 mm long, 8–12 mm wide; outer surface glabrous, pale lilac, unspotted; inner surface white, pale mauve to fawn-spotted near centre, glabrous except for scattered villous-arachnoid hairs extending down from below the medial lobe of lower lip; lobes pale lilac, unspotted, subequal, spreading, obtuse. *Stamens* 4, included; filaments glabrous; anthers glabrous. *Ovary* ovoid, 4-locular with 1 ovule per locule, 2–3 mm long, 1.2–1.5 mm wide, glabrous; style 10–12 mm long, glabrous. *Fruit* dry, ovoid-conical, 3–4 mm long, 2–2.5 mm wide, rugose, glabrous. Seed unknown. (Figure 1)

Diagnostic features. *Eremophila subangustifolia* is distinguishable from other members of *E.* sect. *Australophilae* Chinnock by the following combination of characters: erect to spreading, much-branched shrub 1–2.5 m high, 2–4 m wide; branches, leaves and sepals with dense, grey-white dendritic hairs; leaves linear-subterete, 6–17 mm long, 0.5–1 mm wide; flowers 1 per axil; pedicel terete, 5–7 mm long; corolla pale lilac; outer corolla, ovary and fruit glabrous.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 23 Feb. 1997, *J.A. Cochrane* JAC 2289 (PERTH); 27 Aug. 1948, *C.A. Gardner* 9109 (PERTH, 4 sheets); 20 Aug. 1982, *S.D. Hopper* 2478 (PERTH); 6 Jan. 1992, *S.J. Patrick* SP 931 (PERTH); 6 Jan. 1992, *S.J. Patrick* SP 932 (PERTH); 20 Jan. 2014, *B. & P. Phillips s.n.* (PERTH); 2 Sep. 1993, *L. Sweedman* 3350 (PERTH).

Distribution and habitat. Found near Eneabba in the Geraldton Sandplains bioregion (*sensu* Department of the Environment 2013), growing on slightly saline, pale brown sandy clay on the margins of seasonally wet flats and lakes. Associated species include *Acacia saligna*, *Casuarina obesa* and *Melaleuca rhaphiophylla*.

Phenology. Predominantly flowers from June to October.

Figure 1. *Eremophila subangustifolia*. A – plant showing the spreading habit of the species when mature; B – branch showing the characteristic linear-subterete leaves, long flower pedicel and pale lilac flowers; C – corolla showing the white, pale mauve to fawn-spotted inner tube and scattered villous-arachnoid hairs. Photographs by A. Brown.

Conservation status. *Eremophila subangustifolia* is listed as Threatened Flora in Western Australia (Smith & Jones 2018), under the phrase name *E.* sp. Narrow leaves (J.D. Start D12-150) and is ranked as Critically Endangered. The species is confined to a single location near Eneabba where it comprises two narrowly separated populations (these may have been one continuous population prior to clearing). Flooding in 1999 caused a substantial decline in Population 1 and just 66 plants were located in November 2013. Population 2 has declined from *c.* 10,000 mature plants in 1992 to just 16 plants in January 2014.

Etymology. From the Latin *sub-* (somewhat), *angustus* (narrow) and *-folius* (-leaved), in reference to the narrower leaves of this species compared to those of the related *E. microtheca*.

Affinities. *Eremophila subangustifolia* belongs to *E.* sect. *Australophilae*, which comprises 33 species, 30 of which are endemic to Western Australia. Within this section, *E. subangustifolia* appears closest in morphology to *E. microtheca* and is similarly characterised by its finely dendritic-pubescent branches, leaves and sepals, strongly aromatic leaves, and small, pale lilac flowers. It differs, however, in its (when mature) larger, more spreading habit 1–2.5 m high × 2–4 m wide (0.8–1.5 m high × 0.3–1 m wide in *E. microtheca*), its longer, narrower leaves 6–17 mm long × 0.5–1 mm wide (3–7 mm long × 1.5–2 mm wide in *E. microtheca*), its longer flower pedicel 5–7 mm long (1–2 mm long in *E. microtheca*) and its larger flowers 12–15 mm long × 8–12 mm wide (10–12 mm long × 5–8 mm wide in *E. microtheca*).

Eremophila subangustifolia does not grow with or near other species in *E.* sect. *Australophilae*. The only other *Eremophila* species to occur near *E. subangustifolia* is the unrelated *E. glabra* (R.Br.) Ostenf.

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We thank Rob Davis who accompanied one of us (Andrew Brown) when conducting field studies comparing this new species with its close relative *E. microtheca* and who made valuable comments during discussions about these two taxa. We also thank Anthea Jones for assessing the conservation status of this species, staff at the Western Australian Herbarium for their assistance, and staff at the Royal Botanic Gardens Victoria who kindly provided us with a scan of the type of *E. microtheca*.

References

Department of the Environment (2017). *Australia's bioregions (IBRA)*, IBRA7, Commonwealth of Australia. https://www.environment.gov.au/land/nrs/science/ibra#ibra [accessed 4 May 2017].

Chinnock, R.J. (2007). *Eremophila and allied genera: a monograph of the plant family Myoporaceae*. (Rosenberg Publications: Dural, New South Wales.)

Llorens, T.M., Macdonald, B., McArthur, S., Coates, D.J. & Byrne, M. (2015). Disjunct, highly divergent genetic lineages within two rare *Eremophila* (Scrophulariaceae: Myoporeae) species in a biodiversity hotspot: implications for taxonomy and conservation. *Botanical Journal of the Linnean Society* 177: 96–111.

von Mueller, F. (1882). *Systematic census of Australian plants, with chronologic, literary and geographic annotations. Part 1, Vasculares*. p. 104. (M'Carron, Bird & Co., for the Victorian Government: Melbourne.)

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 29 January 2018].

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SHORT COMMUNICATION

Reinstatement and lectotypification of *Calandrinia tepperiana* (Montiaceae)

William Vincent Fitzgerald made numerous plant collections when he made two expeditions to the Kimberley region, on the Crossland Expedition in 1905 and a separate one in 1906. His collections from these trips included many new species that are described in Fitzgerald (1918). One of the species in that publication, *Calandrinia tepperiana* W.Fitzg., is described as an erect, glabrous, annual with terete, fleshy basal leaves, having up to several scapes ending in short racemes, and flowers with six to eight, lanceolate petals. Furthermore, flowers had numerous stamens, four stigmas, and four-valved, ovoid capsules with numerous smooth and shining seeds. In his description, Fitzgerald cites two collections he made from the May and Lennard Rivers 'in grassy sandy spots'. These locations are within the current IBRA bioregion of Dampierland, typically characterised by plains with red, sandy soils.

Calandrinia tepperiana remained as a current name for Western Australia's flora until West (1992) synonymised it under *C. quadrivalvis* F.Muell. in *Flora of the Kimberley Region*. These species are certainly similar in many respects including habit, size of inflorescences, and particularly seed shape and size. However, *C. tepperiana* differs in having terete basal leaves, rather than the flat to very compressed leaves seen on *C. quadrivalvis*, and whereas the latter is often papillate on the basal leaves, stems and sepals, *C. tepperiana* is never papillate. *Calandrinia tepperiana* nearly always has eight to ten petals (rarely 7 or 11) while *C. quadrivalvis* most commonly has six petals (rarely 7). It also differs in having seeds that are quite smooth and glossy, but occasionally are also lightly colliculate, while *C. quadrivalvis* seeds are somewhat duller, usually with a strongly colliculate surface pattern. It is true that the seeds of the Kimberley collections of *C. tepperiana* can often be similar in size to *C. quadrivalvis* (i.e. 0.4 mm long), but they can also be significantly larger (i.e. 0.5 mm long) and particularly larger in the Pilbara where they can be up to 0.6 mm long.

Apart from the obvious morphological differences listed above, the two species are separated geographically by the King Leopold Ranges. This range marks the boundary between the IBRA bioregion of Dampierland to the west and the bioregions of Northern Kimberley and Central Kimberley to the east. *Calandrinia tepperiana* occurs to the west and south-west of this range on the red, sandy pindan soils while *C. quadrivalvis* occurs to the north-east and east on different geology and soils. The distribution of *C. tepperiana* further southwards into the Great Sandy Desert bioregion is on similar sand dune country to the pindan, but in the Pilbara bioregion it is usually restricted to unconsolidated sandy soils on dry creek- or river-beds and adjacent floodplains.

We suspect that Fitzgerald, after crossing the King Leopold Ranges eastwards, saw specimens of *C. quadrivalvis* with six petals, and believing these to be *C. tepperiana*, included this minimum number (i.e. 6–8 petals) within his species concept. It is also possible that he came to this conclusion after seeing aberrant or stunted plants with six petals. In summary, it is the terete basal leaves with no papillae, the higher petal number and the different distribution that clearly separate *C. tepperiana* from *C. quadrivalvis*.

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Taxonomy

Calandrinia tepperiana W.Fitzg., *J. Proc. Roy. Soc. Western Australia* 3: 141–142 (1918).

Type citation: 'May and Lennard Rivers (W.V.F.).' *Type specimens*: May River, near Poulton's yards [Kimberley region, Western Australia], May 1905, *W.V. Fitzgerald* 431 (*lecto*, here designated: PERTH, image seen); 6 miles N.E. of Mount Eliza [near the Lennard River, Kimberley region, Western Australia], May 1905, *W.V. Fitzgerald* 739 (NSW, image seen).

Semi-erect to erect *annual* (possibly sometimes perennial) *herbs*, 40–270 mm tall, 35–300 mm wide, glabrous, the root system comprising a long, weak to relatively strong taproot with numerous finer roots, occasionally with a few intermediate-sized lateral roots. *Basal leaves* up to 120 mm long and 5 mm wide, fleshy, cylindrical, terete to sub-terete in T.S., forming a dense tuft. *Stems* usually short, up to *c.* 50 mm long, radiating from base, merging into erect scapes, the junction not always clear. *Stem leaves* rare, fleshy, narrowly linear to narrowly obovate, up to 20 mm long and 1.5 mm wide, usually terete, sometimes compressed. *Scapes* roughly up to 135 mm long, with two or more evenly scattered residual bracts, occasionally once- or twice-branched. *Inflorescence axis* up to 165 mm long, bare except for 3 to several ± scarious bracts, mostly opposite particularly on the upper axis, 3–9-flowered, generally forming a loose cyme. *Inflorescence axis bracts* appressed to ± spreading, narrowly triangular, occasionally broader, up to 4 mm long and 3 mm wide, apex acuminate. *Pedicels* up to 25 mm long, erect, to 55 mm long in fruit and moderately to strongly reflexed. *Flowers* 8–20 mm diam. *Sepals* moderately thick, ovate to broadly ovate, up to 5 mm long and 6.5 mm wide, free to base, mucronate, veins and reticulation not always prominent. *Petals* 8–10 (rarely 7 or 11), light to mid-pink, sometimes darker pink or white, elliptic to obovate, up to 9.5 mm long and 4.5 mm wide, free to base, occasionally mucronate. *Stamens* generally >25, >35 on larger flowers; filaments free, roughly to 4 mm long, attached to the top of basal ring beneath ovary; anthers elliptic to oblong in outline, roughly to 1 mm long and 0.4 mm wide, versatile, extrorse, dehiscing longitudinally, often pink-purple before anthesis. *Ovary* ovoid, roughly 1–2.5 mm diam., brown; stigmas 4, narrowly triangular to linear at maturity, to 3.6 mm long, free to base, with a dense covering of moderately long stigma trichomes. *Capsule* ovoid to broadly ovoid, 3.5–6 mm long, 2.8–3.5 mm wide, the apex obtuse and usually longer than the sepals; valves 4, at first splitting at the summit then to the base with age. *Seeds* numerous per capsule, tan to mid- to dark brown, occasionally almost black, shiny, globular to sub-reniform, to 0.6 mm long, 0.45 mm wide, 0.3 mm thick, surface pattern usually smooth, sometimes weakly colliculate and only noticeable at higher magnification.

Selected specimens examined. WESTERN AUSTRALIA: 10 km E of South Hedland, 24 June 1981, *P. Armstrong s.n.* (PERTH); Ngarrin Creek, Warrawagine Road, NE of Marble Bar, 24 June 2006, *A.R. Bean* 25156 (PERTH); bed of Yanarrie River at Homestead Pool, Millawitty Pool, Nyang Station, 4 May 2004, *G. Byrne* 934 (PERTH); Taylors Lagoon, Broome, 25 July 2008, *G. Byrne* 3497 (PERTH); drill site named Missing, northern Great Sandy Desert, 30 Sep. 2001, *C.P. Campbell* 3924 (PERTH); Bulka Swamp, Bohemia Downs Station, S Kimberley, 3 July 2001, *K. Coate* 633 (PERTH); *c.* 3 km S of Skull Springs Road, on 5 Mile Creek, E of Nullagine, 28 Aug. 2004, *R. Davis* 10722 (PERTH); saline flat just to the N of the Derby-Gibb River Road, *c.* 10 km out of Derby, 8 May 1988, *E.M. Goble-Garratt* 519 (PERTH); Great Sandy Desert, W of the Lamil Hills, Telfer area, 4 July 2002, *R.P. Hart* 7985 (PERTH); Sunday Island, Buccaneer Archipelago, 9 June 1982, *A.J.M. Hopkins* BA 0002 (PERTH); 4.8 km NW of Beagle Bay Aboriginal Community, Dampier Peninsula, W Kimberley, 21 June 1984, *K.F. Kenneally* 9126 (PERTH); Bea Bea middle creek, 22 km N from Mulga Downs turnoff along Great Northern Highway, Pilbara region, 4 Aug. 2015, *F. Obbens* 05/15 (PERTH); Yule River, 21.3 km E along North West Coastal Highway from junction with Great Northern Highway,

5 Aug. 2015, *F. Obbens* 09/15 (PERTH); along Marble Bar Road *c.* 20.7 km S from the Warralong turnoff and next to Yandicoogina Creek, 26 May 2004, *F. Obbens & B. Bromilow* FO 11/04 (PERTH); *c.* 6 km E along Newman rail access track from the Great Northern Highway-Wodgina mine access road intersection. Site is at the track crossing of the Turner River and area is *c.* 90 km directly S of Port Hedland, 29 May 2004, *F. Obbens & B. Bromilow* FO 21/04 (PERTH); West Kimberley, Lennard Hills, area of shale and granite outcrops near the Gibb River Road, *c.* 12 km W of Inglis Gap, 5 June 1988, *M. Sands* 5156 (PERTH); 1.1 km N towards the Petrified Forest campsites from junction of Barred Creek Road, S of the Prices Point Road, 7 June 2006, *L.S.J. Sweedman* 6793 (PERTH); site number 88, 10.9 km ESE of Mount Sabine, Millstream-Chichester National Park, Fortescue Botanical District, 16 Apr. 1997, *M.E. Trudgen* MET 15210 (PERTH); Pelican Pool, Nullagine River, Meentheena Conservation Reserve, 12.5 km SW of Meentheena Station Homestead, 11.4 km SSW of King Rock Hole, 20.7 km NW of Baroona Hill, 23 May 2001, *S. van Leeuwen* 4780 (PERTH); by bridge over River De Grey, North West Coastal Highway [Great Northern Highway], 26 June 1988, *P.G. Wilson* 13024 b (PERTH).

Phenology. The main flowering and fruiting period occurs from April to September and reflects the large geographic distance between northern populations and those populations much further south, and also somewhat seasonal variations within these regions. Two collections from the Kimberley region were taken outside this period (i.e. in January and February), but still appear to be *C. tepperiana*.

Distribution and habitat. *Calandrinia tepperiana* is widespread in the bioregions stated above. While habitat has been described above at a landscape level, it is considerably more variable between sites at the local scale, particularly in the Kimberley and adjacent areas. For example, many collections in the Kimberley are recorded as being from typical habitat of red to brown sandy soils in dune swales, flats or floodplains, while a number of others were recorded from grey clayey sand or on stony ground or red, sandy laterite, and even one in a saline situation near a soak under *Pandanus* sp. and behind a mangrove area. The vegetation communities recorded for the Kimberley also varied from grasslands to low-tree savanna to shrublands or lake-edge herbfields. Some of the associated species included *Acacia colei*, *Grevillea striata*, *Triodia pungens*, *Lysiphyllum cunninghamii*, *Eucalyptus* sp. and *Corymbia* sp.

For the Pilbara, *C. tepperiana* consistently occurs on the dry beds of water courses or adjacent banks or on previously flooded areas. The soils recorded in the Pilbara range from light red or orange-brown sands to brown sandy loams, often described as gritty or gravelly, and sometimes silty. Predominantly, the vegetation communities were described as riverine or mixed medium shrublands with a wide range of associated species, including *Eucalyptus camaldulensis*, *Acacia ampliceps*, *A. coriacea* subsp. *pendens*, *Melaleuca lasiandra*, *M. linophylla*, *Cyperus vaginatus*, *Eragrostis cumingii*, *Tephrosia rosea* var. *clementii*, *Pluchea tetrandra*, *Crotalaria cunninghamii*, *Chrysopogon fallax*, *Stemodia viscosa* and *Goodenia lamprosperma*; grass weed species also regularly occur at these sites.

Conservation status. *Calandrinia tepperiana* occurs over a very large area and is not considered under threat. There are 54 collections at PERTH.

Typification. A lectotype has been designated here to fix the application of the name *C. tepperiana*. The chosen specimen is the better of the two syntypes; however, both collections are quite poor and do not adequately display some of the key characters that define the species. Barcodes have not been provided for the type specimens because both have been on loan to CANB for an extended period and have therefore not been databased at their respective institutions.

Affinities and notes. A recent molecular phylogeny of Australian *Calandrinia* Kunth (Hancock *et al.* 2018), has shown that *C. tepperiana* and *C. quadrivalvis* are clearly separate taxa; the phylogenetic tree placing them in the same clade (i.e. sect. *Basales* von Poellnitz), but with numerous intervening species. In this phylogeny, *C. tepperiana* is sister to *C. pleiopetala* F.Muell. with 100% bootstrap support. *Calandrinia pleiopetala* is an eight-petalled species with smaller, strongly colliculate seeds that occurs in more inland areas than *C. tepperiana*.

Species of *Calandrinia* within the distribution of *C. tepperiana* (a 4-valved species) and with a similar number of petals to it include *C. pentavalvis* Obbens (a 5-valved species) and *C. strophiolata* (F.Muell.) Ewart, B.Rees & B.Wood (a 6-valved species). These three species are all erect plants, but differ significantly in their seed morphology. *Calandrinia uniflora* F.Muell. (a 4-valved species) with eight to 12 petals is clearly distinct from *C. tepperiana* in having a single-flowered inflorescence at the end of each scape, and the distributions of these two species barely overlap.

It is clear that the remaining collections of *C. quadrivalvis* from the central, northern and eastern Kimberley region contain other undescribed segregates alongside true *C. quadrivalvis*. The authors are currently studying this group and a publication on this topic will be forthcoming.

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References

Fitzgerald, W. (1918). The Botany of the Kimberleys, North-West Australia. *Journal and Proceedings of The Royal Society of Western Australia* 3: 102–224.

Hancock, L.P., Obbens, F., Moore, A.J., Thiele, K., de Vos, J.M., West, J., Holtum, J.A.M. & Edwards, E. (2018). Phylogeny, evolution, and biogeographic history of *Calandrinia* (Montiaceae). *American Journal of Botany* (in press).

West, J. (1992). *Calandrinia*. *In*: Wheeler, J.R. (ed.) *Flora of the Kimberley region*. pp. 134–135. (Department of Conservation and Land Management: Perth.)

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The Australian plant collections of Diels and Pritzel 1900–1902

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Abstract

Gibson, N. The Australian plant collections of Diels and Pritzel 1900–1902. *Nuytsia* 29: 25–56 (2018). Ludwig Diels and Ernst Pritzel undertook a two year collecting trip between 1900–1902 that included Western Australia, the eastern seaboard and New Zealand. Material collected on this expedition resulted in publication of over 300 new taxa. The loss of many of Diels' types during a bombing raid on Berlin in 1943 has resulted in a need to designate neotypes for many of these names. The history and possible nomenclatural significance of the joint collections they donated to the Western Australian Museum in 1901 is examined to assist identification of candidate material.

Introduction

Between 1900 and 1902 two young Germans, Ludwig Diels and Ernst Pritzel, undertook a scientific expedition that visited South Africa (2 months), Western Australia (14 months), and the eastern seaboard of Australia and New Zealand (6 months). During that time they amassed thousands of collections in four series of numbers. These collections have particular nomenclatural interest as they formed the basis of over 300 novel taxonomic descriptions published as *Fragmenta Phytographiae Australiae occidentalis* in Engler's *Botanische Jahrbücher* (Diels & Pritzel 1904–1905). Of these, some 126 are currently in use.

Diels largely collected unicates and these were deposited in the herbarium of the Royal Botanical Museum in Berlin (now the Berlin-Dahlem Botanical Garden and Botanical Museum (B)). His travels were financed with a grant from the Humboldt Foundation to prepare an account of the vegetation formations of Western Australia and conduct an investigation of the conditions influencing the development of the wide range of species existing in the flora (Diels 1906, 2007). From his publications and surviving specimens he appears to have made 4,660 collections in Western Australia and a significant number of additional collections in South Africa, New Zealand and eastern Australia (Table 1).

Pritzel, on the other hand, personally financed his part of the expedition by collecting multiple sheets for his *Plantae exsiccatae Australiae occidentalis*. This comprised 1,016 taxa numbered sequentially and listed at the end of the *Fragmenta*. On his return to Germany he sold many of the duplicates and these have made their way into herbaria across the world. While the number

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Table 1. Diels' collection numbers for years 1900–1902.

Location	Collection numbers	Period
South Africa	1–1499	August – October 1900
South-western Australia	1500–6160	30th October 1900 – 28th December 1901
Eastern Australia & New Zealand	6161–8706[1]	4th January 1902 – 17th June 1902
New Guinea & South-east Asia	none	June 1902

[1]This being the highest number located to date

of duplicates collected was not documented in the *Fragmenta*, over 20 sheets per taxon have been located for some taxa (e.g. *Pritzel* 849, 858; *Global Plants* accessed 21 April 2017).

In addition to these well-known sequences there are at least two additional extant series. The first is joint collections of *Diels & Pritzel* that were presented to the Perth Museum (now Western Australian Museum – WAM) as part of the agreement for permission to collect in Western Australia and for the use of railway passes that facilitated their extensive excursions (State Records Office of Western Australia 1900). These collections were eventually passed from the WAM to the State Herbarium Western Australia (later renamed Western Australian Herbarium (PERTH)) in 1957. The current holdings comprise some 568 sheets, some of which are unnumbered. Two further sheets of this set have been located outside of PERTH, both in the herbarium of the Natural History Museum of Denmark (C).

The final series is of fungi collected by Pritzel in New South Wales and Queensland in the first half of 1902 and described by Hennings (1903). Hennings listed 123 Pritzel collections, with the highest number in the sequence being 163. Hennings (1901a) had previously described 13 new taxa taken from Diels' and Pritzel's individual collections appending an 'a' to their collection numbers, and a further six taxa from unnumbered Pritzel collections (Hennings 1901b).

Most of the herbarium at the Royal Botanical Museum in Berlin was destroyed by a bombing raid on the night of 1st March 1943, resulting in the loss of a large part of their holdings (Hiepko 1987). While some types had been evacuated earlier in the war most of Diels' Australian collections were lost with less than 100 surviving in B (Röpert 2000–). Most of the surviving collections are types (75 of 92 sheets). In addition some 56 of Pritzel's Australian collections can be found in B; 54 of these are types (Röpert 2000–). Databasing of B material is continuing and more material may be uncovered.

Many of the new taxa described in the *Fragmenta* were based on Diels' and Pritzel's collections. For those names where the types were destroyed it has been necessary to designate neotypes (where only Diels' collections were cited) or lectotypes (where Pritzel's collections were cited). Finding adequate material to lectotypify Pritzel's types is generally straightforward given the wide distribution of his collections.

Some authors have considered the joint *Diels & Pritzel* collections found in PERTH to be duplicates of type material cited in the *Fragmenta*. Recent research into the history of this material throws some doubt on this interpretation. The aim of the present study is to describe the three non-fungal collection series and examine the nomenclatural status of their joint collections.

Diels' collections

Diels' Australian collections have a specific label headed 'L. Diels, Reise in Auftrag der Humbolt – Stiftung.' [L. Diels, journey on behalf of the Humbolt Foundation]. Under the header is printed 'No.' for his collection number, followed by a space for the taxon name. An abbreviated family name is often given on the top right under the header. Immediately under the taxon name is space to insert the equivalent Pritzel number; this is only occasionally used. A brief description of the collection is often inserted above the location information. The location information starts with 'West-Australien:' then he typically wrote the land district or his botanical district followed by more specific information. Space for the date is found on the lower left of the label and Diels' name is printed on the lower right of the label. It is noted that Diels invariably gave the full date (Figure 1).

Most of Diels' material was lodged in B, with small amounts now to be found in the British Museum (BM), Kew (K), National Herbarium of New South Wales (NSW), National Herbarium of Victoria (MEL) and PERTH (*Global Plants* accessed 21 April 2017). Material for the first three appears to be the result of normal herbarium exchanges. The material in MEL and PERTH has a more complicated history. Diels and Pritzel spent a week or two at MEL in March 1902 before heading back to Europe (Ewart 1907). Diels obtained some collections from MEL that he took back to B. These included sheets of Drummond, Brown and Mueller types. To these he affixed his own label and annotated them 'ex Herb. Melbourne, comm. L. Diels' and gave them his collection numbers (e.g. 7345, 7346, 7348, 7455, 7463, 8014, 8019, 8024, 8026 extant in B). At that time J.G. Luehmann was Curator of the National Herbarium Melbourne and Government Botanist and no doubt sanctioned the transfer of this material.

The subsequent Government Botanist Alfred Ewart took a dimmer view of Diels' acquisitions and pursued a correspondence with Diels for some years, seeking a set of their Western Australian material. In a letter to Maiden in May 1907 Ewart wrote '*By the way Diels & Pritzel seem to have been allowed to plunder our herbarium to a remarkable extent when they were here some years ago for a few weeks time. I can hardly believe that it was done with Luehmann's sanction, as they have even "stolen" one of his species in the most barefaced manner, & we have nothing to show in exchange. It is difficult to know what to do in such cases*' (Ewart 1907). In 1909 Diels appears to have sent 12 sheets to MEL, 11 of which were types, and five of which have a distinctive blue label not seen on any other of his collections. None of this material bears his 1901 label.

Over 230 sheets of Diels material can be found in PERTH, most having been obtained by C.A. Gardner when he visited the Berlin herbarium in 1937 while serving as Australian Botanical Liaison Officer at Kew. Gardner and Diels had corresponded since 1923 and while in Berlin Gardner took fragments off at least 150 of Diels' Western Australian collections, of which 35 represent types. This material was subsequently mounted and labelled with Diels' number and are considered duplicates of the B sheets (Figure 2). Another set of 63 sheets of Diels material came to PERTH from the Blackall Herbarium and may represent other material obtained by Gardner in Berlin in 1937.

Pritzel's collections

Pritzel's Western Australian collections similarly have a specific label headed 'E. Pritzel: Plantae Australiae occidentalis' [E. Pritzel: Flora of Western Australia]. As with Diels' labels the first line under the header is printed 'No.', then there is a space for his number and taxon name. Following this is a printed description of the location and general vegetation (different for different regions).

Figure 1. *Diels* 1717, *Grevillea purdieana* Diels, showing the label Diels used on all his Australian collections. Source: Röpert (2000–), published at http://ww2.bgbm.org/herbarium/ (Barcode: B 10 0279538 / ImageId: 294718) [accessed 27 April 2017].

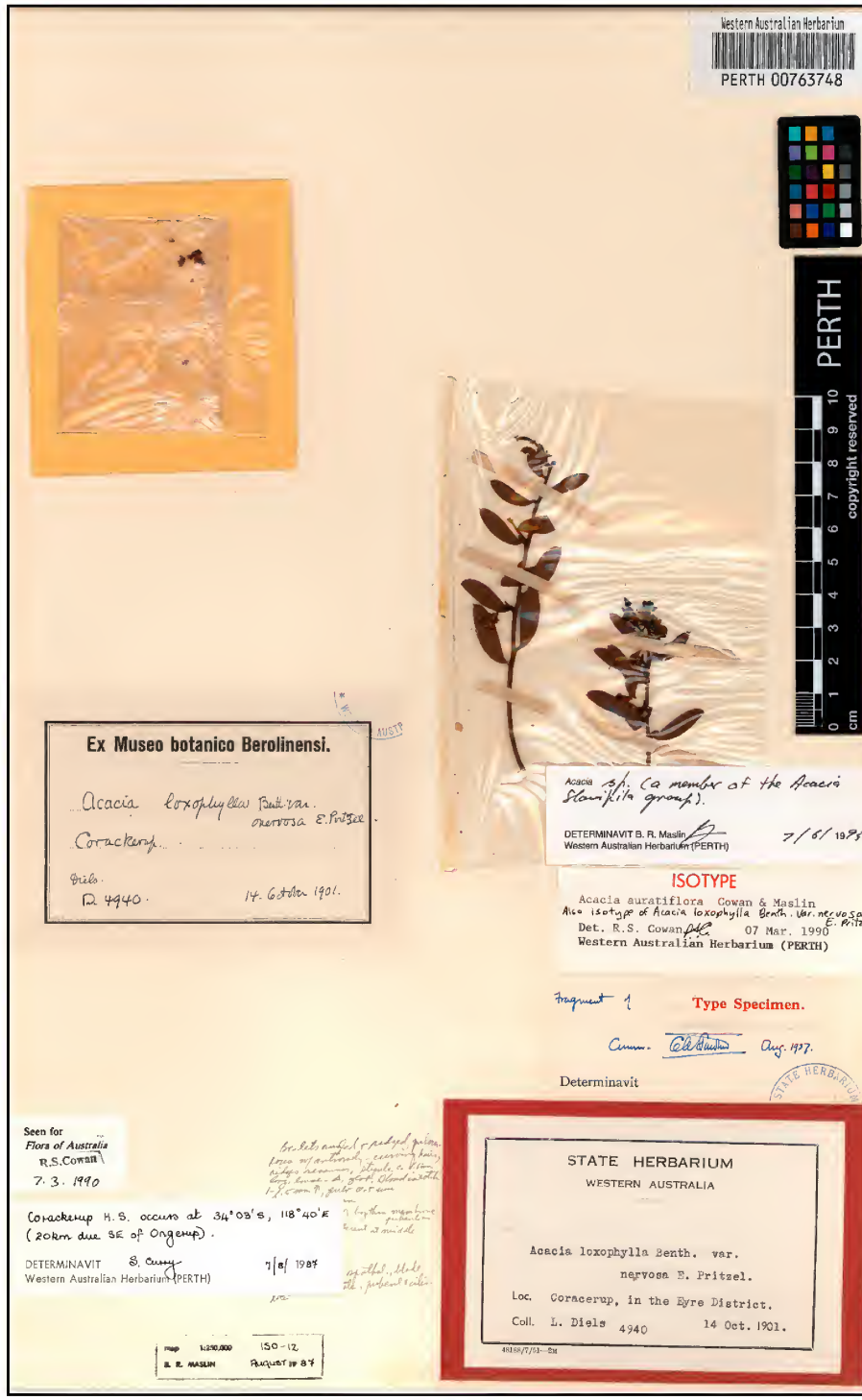

Figure 2. Fragment of *Diels* 4940 removed by Gardner from type in B in 1937 and later remounted; the B label (in Gardner's hand) appears to have been moved to accommodate the State Herbarium Western Australia label. Source: PERTH.

The date appears at the lower left, generally only the month and year, and 'leg. E. Pritzel' [collected E. Pritzel] is printed on the lower right (Figure 3). The collections of this set found in B generally have an additional hand written slip with collection number, taxon name, location description, month, year, and 'leg. E. Pritzel' (Figure 3). These B collections are occasionally lacking the Plantae Australiae occidentalis label but rather have a general B label or a label of Pritzel's herbarium (Table 2). All material seen is however consistently numbered as given at the end of the *Fragmenta*.

There are some 443 sheets of Pritzel material in PERTH. As with the Diels collections, Gardner removed duplicate material from some B sheets on his visit there in 1937. This material was subsequently incorporated into PERTH. It is also possible that some Pritzel material in PERTH resulted from an earlier exchange between Diels and Gardner. Diels had written to Gardner in 1923 suggesting an exchange of some Western Australian material for 'a good Pritzel set' (Appendix 1). While subsequent correspondence has not been located it seems likely that this exchange went ahead, based on collections in PERTH and B. A good number of Pritzel sheets in PERTH have Plantae Australiae occidentalis labels and came from the Herbarium Gardnerianum (Gardner's private herbarium, e.g. *Pritzel* 849, Gardnerianum 131; PERTH 01607820). In addition, at least three Gardner types have been located in B that have accession dates consistent with such an exchange (5th September 1925). These three sheets have labels headed 'Herbarium of C.A. Gardner, Flora of Western Australia' (B 10 0295158, B 10 0295424, B 10 0279563). Gardner continued to send types to B until at least 1939 (B 10 0272767).

Diels & Pritzel's joint collections

The joint *Diels & Pritzel* collections also have a particular label, although duplicate material does not. The label is headed in English 'Flora of Western Australia'. Under the heading is printed 'No.' followed by space for collection number and taxon name. On the second line is printed 'Locality' then space for the district and a specific location. There is space at the beginning of the third line for the month and year followed by the phrase 'Collected and presented by Dr. Diels and Pritzel' (Figure 4).

With the exception of *Astroloma baxteri* DC. no direct reference to joint *Diels & Pritzel* collections is found in the *Fragmenta*. The description of that taxon includes 'pr. Cape Riche (Moir 1903), Albany et Denmark (D. et Pritzel)'. This appears to refer to an extant collection in PERTH from their joint series (PERTH 02982609 [WAM accession 439] *Diels & Pritzel* 383 Plantagenet Dist.: Albany, March 1901).

These joint collections never left the colony; the donation of two tranches of this material to the WAM is documented in *The West Australian* newspaper (126 plants 18th April 1901; 138 plants 7th August 1901). Further, a WAM register of botanical specimens has been located (PERTH library archive) which allocates accession numbers to Diels' donations on 15th July 1901 (B1–B138) and a second sequence on 12th September 1921 (B1708–B1759) of previously unincorporated 1901 material. It is assumed that the collections were donated unmounted with one label per collection. Much of the collection information from the *Diels & Pritzel* label was transcribed onto the sheet on which their collections were mounted and had a WAM accession number added in either of two different formats.

The first format has a number corresponding to the 'B' numbers recorded in the WAM register on the top left of the sheet and then the taxon name and 'D – Dr Diels' on the bottom left, sometimes with locality information (Figure 5). The 'D' presumably meant 'donated by'. Currently in PERTH there are 152 sheets of the 190 'B' numbers recorded in the WAM register. One collection (*Diels & Pritzel* 43, PERTH 03608174) has WAM accession number 1587 and lacks the 'B' prefix. Nonetheless this number corresponds to an entry in the WAM register regarding a collection of a Miss Wood. Label

Table 2. Additional labels found on Pritzel's Australian collections in B.

Label	Example
Herbarium E. Pritzel	http://herbarium.bgbm.org/object/B100379003
Museum botanicum Berolinense Herbarium E. Pritzel [Hand written subheading]	http://herbarium.bgbm.org/object/B100379004
Museum botanicum Berolinense	http://herbarium.bgbm.org/object/B100365994
[Ex] Museo botanico Berolinensi [Ex crossed out on some labels]	http://herbarium.bgbm.org/object/B100278848

information from two different collections appears to have been transcribed onto this sheet but it clearly represents a *Diels & Pritzel* collection.

The second format is an elegant copper plate script with a WAM accession number, the taxon name, 'D – Drs Diels & Pritzel' and the location written across the bottom of the sheet (Figure 6). These accession numbers are not prefixed by the letter 'B' and do not appear to be recorded in the WAM register. There are 286 sheets in this set, their numbering appears sequential (7–753) with most missing blocks generally being runs of less than five numbers. It seems likely that allocation of accession numbers would have been systematic, implying that a good deal of the original donation (perhaps 450 sheets) may have been lost. Why there are these two different formats and why only one appears in the WAM register remains unclear.

Both of these formats generally come with two further labels: a label recording the transfer from the WAM to the State Herbarium and a separate State Herbarium Western Australia (or PERTH label, sometimes both) that duplicates information on the *Diels & Pritzel* labels and the location information on the bottom of the sheet. The State Herbarium Western Australia label often has the WAM accession number written on the lower left of the label.

All presumed duplicate sheets (of the same taxon collected at the same location in the same month) are lacking *Diels & Pritzel* labels, probably indicating that only one label per collection was provided. Other sheets either lack the WAM annotations (Figure 4), or the *Diels & Pritzel* labels, or both. This appears to have resulted from curation activities in the 1960s when the collections were lifted off the sheets and the specimens were dipped in mercuric chloride/phenol/alcohol solution. If the original mounting sheet or label, or both, were badly damaged they were discarded and the material remounted and relabelled (A.S. George pers. comm.). It is often possible to infer the original WAM accession number from the annotation on the lower left of the State Herbarium Western Australia label.

The two sheets at C, both species of *Leucopogon* R.Br., appear to be duplicates of *Diels & Pritzel* collections in PERTH (PERTH 02991284, PERTH 02991799) as the C sheets lack *Diels & Pritzel* labels and the date (month/year) and location match the PERTH material. These sheets are stamped with 'Herb. C.H. Ostenfeld', who was at one time the keeper of the Botanical Museum in Copenhagen and who collected extensively in Western Australia from August–October 1914. He was acquainted with both B.H. Woodward (Director of the Perth Museum) and W.B. Alexander (Keeper of Biology, Perth Museum) from who this material was probably obtained (Ostenfeld 1916). He later described several *Leucopogon* species from his Australian collections (Ostenfeld 1921).

Figure 3. *Pritzel* 78, *Grevillea purdieana* Diels, showing both Pritzel's typical label and the slip with additional information often found on B sheets. Source: Röpert (2000–), published at http://ww2.bgbm.org/herbarium/ (Barcode: B 10 0279537 / ImageId: 294717) [accessed 27 April 2017].

Figure 4. *Diels & Pritzel* 39, *Grevillea purdieana* Diels, showing their typical joint label. This sheet lacks WAM accession number and hand written script. The original sheet was probably discarded in the 1960s when mercuric chloride treatment was applied (A.S. George pers. comm.). Source: PERTH.

Figure 5. *Diels & Pritzel* 507 showing one style of hand written script on the original WAM sheets. Note the 'B' prefix on the accession number (B54, top left). These numbers are consistent with entries in the original WAM register of botanical specimens (B1–B134; B1708–1759), with the *Diels & Pritzel* material being the first entry in the register dated 15th July 1901. Additional WAM transfer, State Herbarium Western Australia and PERTH labels have been added. The newer style of PERTH label in lower right dates from the 1970s (A.S. George pers. comm.). Note also the manuscript name in Diels' hand. Source: PERTH.

Figure 6. *Diels & Pritzel* 336 showing the second style of copper plate script on the original WAM sheets. This style lacks the 'B' prefix to the accession number (156, above taxon name) and this sequence does not appear in the WAM botanical register. Note the transfer of the WAM accession number to the lower left hand corner of the State Herbarium Western Australia label. Source: PERTH.

Some *Diels & Pritzel* collections do not follow the patterns described above. Five sheets of Lauraceae and five sheets of Orchidaceae do not appear to have been part of the WAM collection as they lack any WAM annotations and labels indicating the transfer, and the PERTH database does not suggest a WAM origin. These families are not otherwise represented in the extant *Diels & Pritzel* collections. The five sheets of *Cassytha* L. have *Diels & Pritzel* labels and numbers and may have either been removed from WAM before accessioning was completed or may have been passed directly to a local colleague by Diels or Pritzel.

Three of the five orchid sheets also have *Diels & Pritzel* labels but no collection numbers. The two remaining sheets have hand written slips (not in Diels' or Pritzel's hand) indicating they were collected by *Diels & Pritzel* (one initialled BTG). These also lack collecting numbers and in addition they have labels headed 'State Herbarium of Western Australia BT Goadby Collection'. Col. B.T. Goadby (1862–1944) was a keen plant collector who made large collections in the Albany area in 1898, 1899 and later (George 2009). He passed a significant number of collections (>500 sheets) to WAM in 1923 and the WAM register recorded further donations of orchids up until June 1932. Some 1,092 sheets collected by Goadby are presently located in PERTH with just under half recorded as coming from the WAM. A further 71 sheets appear to be a specific donation to PERTH from Goadby (date unknown). How he obtained this *Diels & Pritzel* material remains uncertain but could have been directly from Diels and Pritzel, from the WAM before accessioning, or from a third party who had been gifted it at the time of Diels and Pritzel's visit. Given these sheets have no collection numbers it seems unlikely that he obtained them from the WAM.

The three different types of labels used by Diels and Pritzel have been described in detail as there has been considerable confusion correctly identifying their collection numbers (especially of the *Diels & Pritzel* material). Much of the confusion appears to be due to the transcription of the WAM accession numbers onto the State Herbarium Western Australia labels and the translation of this information into the PERTH collections database. Currently the collection number captured in the database variously records the correct collection number (top left of *Diels & Pritzel* label), or the WAM accession number, or Diels or Pritzel (or both) individual numbers that were collected at a similar time and place, or are entirely lacking a collection number. This leads to significant confusion in understanding the provenance of these collections. The correct collection numbers and associated PERTH and C sheet numbers and the WAM accession numbers of all but 14 (11 on loan, 3 not located) of the 570 sheets in this joint series are provided in Appendix 2.

Nomenclatural implications

It has been assumed by some authors that the *Diels & Pritzel* collections represent type or probable type material of names published in the *Fragmenta* (Figures 4–6). It is clear from contemporary newspaper reports and the WAM register that the *Diels & Pritzel* material never left the colony and therefore it is unlikely that the protologues found in the *Fragmenta* were based on this material, nor, with one exception, are these collections cited in the *Fragmenta*. Further, it is not clear if these joint collections always unequivocally represent duplicates of individual Diels and Pritzel numbers. Under the Melbourne Code duplicates are defined as '*Part of a single gathering of a single species or infraspecific taxon made by the same collector(s) at the one time*' (McNeill *et al.* 2012). Under this definition their joint collections could be considered duplicates of one or other of their individual collections but their individual collections would not generally be considered to be duplicates of each other.

In the case of the taxon described by Diels as *Grevillea purdieana* (Figures 1, 3, 4), the protologue lists three valid syntypes *Diels* 1717, *Diels* 1717a and *Pritzel* 78. Duplicates of *Pritzel* 78 are represented

in at least 13 herbaria (Global Plants 2017, accessed 21 April 2017). Diels records Pritzel's number on his own label. The Pritzel labels give the same general location information while more precise location information appears on a hand written slip attached to the collection at B (Figure 3, Table 3). In addition to the originally published syntypes, McGillivray and Makinson (1993) consider *Diels & Pritzel* 39 as a probable part of the type collection and Makinson (2000) considers it as a syntype.

It could be argued that Diels, by listing *Pritzel* 78 on his own label, is indicating that his and Pritzel's sheets were collected at the same time and at the same location (Figure 1). However on some other sheets where Diels lists a Pritzel number he has added 'leg. E. Pritzel' and added 'comm.' before his own name (e.g. *Diels* 3563, B 10 0295430). In such cases the Diels collection is unequivocally a duplicate of the Pritzel material. There are no such annotations on *Diels* 1717. In addition, the lack of a specific date on the Pritzel sheet and the difference in location information cannot rule out the possibility of separate collections made in the same general area sometime in late November 1900 when they were on a collecting trip out to Coolgardie (Diels 2007).

The location information on Pritzel's label is very broad, and without the extra information available on the slip attached to *Pritzel* 78 at B, their joint collection would not be considered a credible duplicate (Table 3). The lack of precise date and differing locational information also make the consideration of the *Diels & Pritzel* sheet as a possible duplicate for *Diels* 1717 problematic.

A stronger case could be made for *Diels & Pritzel* 507 representing original material for the name *Halgania argyrophylla* Diels. The type citation for this taxon reads 'Hab. in distr. Irwin pr. Irwin River et Greenough Riv. (F. v. Müller in hb. Melbourn.!), pr. Northampton in arenosis aridis fruticulosis flor. m. Nov. (D. 5642)'. The label of *Diels & Pritzel* 507 gives 'Victoria Dist.: Northampton, Novemb. 1901' and it seems likely that their joint collection was collected at the same time and place as *Diels* 5642 (Figure 5) and could be considered duplicate material. In addition, Diels' annotation (*Halgania leucophylla* n. sp.; Figure 5) suggests this collection formed part of the basis of the subsequent description, albeit this was not published until some years later. In that case it would also be considered original material (Article 9.3a, McNeill *et al.* 2012).

Table 3. Comparison of temporal and locational data of collections of possible syntypes of *Grevillea purdieana* Diels.

Collection	Date	Location	Translation
Diels 1717	29 Nov. 1900	Yilgarn: 2 ½km westlich von Southern Cross	Yilgarn: 2 ½km west of Southern Cross
Diels 1717a (presumed destroyed)	-	-	-
Pritzel 78 (B - slip)	Nov. 1900	Hügel bei Southern Cross (Yilgarn Goldfields)	Hill near Southern Cross (Yilgarn Goldfields)
Pritzel 78 (label)	Nov. 1900	Yilgarn and Coolgardie Goldfields	
Diels & Pritzel 39	Nov. 1900	Yilgarn Goldfields, Southern Cross	

A reasonable case can also be made for *Diels & Pritzel* 392 being regarded as syntypes of *Acacia microbotrya* Benth. var. *borealis* E.Pritzel, described in the *Fragmenta.* In this case no specific collection number was cited in the description but it was stated that the specimen was 'pr. Mingenew a nobis collecta' [collected by us near Mingenew]. No individual sheets of Diels or Pritzel material of this taxon have been located but two sheets from this location of *Diels & Pritzel* material (*Diels & Pritzel* 392, PERTH 00108081; *Diels & Pritzel* s.n., PERTH 00107603, presumed duplicate of *Diels & Pritzel* 392) can be found in PERTH, annotated as possible syntype and isosyntype, respectively, for this name. From available information and surviving material it appears that this taxon was only collected once, and as such these collections could be regarded as duplicates of that gathering and therefore syntypes for this name.

Seventeen other taxa listed in the *Fragmenta* include the phrase 'a nobis collecta'. Twelve include individual collection numbers but none of these were joint collections. Only five do not cite a collection number, and none of these bear Diels or Pritzel taxon names and so have no nomenclatural implications.

In cases where there is a lack of congruence in the spatial and temporal data between their joint and individual series, the assumption that their joint collections are necessarily duplicates of one of their individual collections needs to be questioned. If in individual cases it is accepted that the *Diels & Pritzel* collection may not be duplicates of the holotype or syntypes and it is accepted that the original descriptions were not based on this material (since it never left Australia nor was it cited) then under the Melbourne Code (McNeill *et al.* 2012) they cannot be considered original material (Article 9.3), although they do represent excellent material from which to select a neotype if no original material can be located.

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References

Diels, L. (1906). *Die Pflanzenwelt von West-Australien südlich des Wendekreises*. (Engelmann: Leipzig.)

Diels, L. (2007). The plant life of Western Australia: south of the tropic. (Translated B.J. Grieve, B.B. Lamont, E.O. Hellmuth, ed. N. Gibson) *Conservation Science Western Australia* 6(2): 1–373.

Diels, L. & Pritzel, E. (1904–1905). Fragmenta Phytographiae Australiae occidentalis. Beiträge zur Kenntnis der Pflanzen Westaustraliens, ihrer Verbreitung und ihrer Lebensverhältnisse. *Botanische Jahrbücher für Systematik, Pflanzengeschichte und Pflanzengeographie* 35: 55–662.

Ewart, A. (1907). Royal Botanic Gardens Melbourne Archive – Manuscript 399a folio 22 to J.H. Maiden 16 May 1907.

George, A.S. (2009). *Australian botanist's companion*. (Four Gables Press: Perth.)

Global Plants (2017). *JSTOR* https://plants.jstor.org/ [accessed 20 April 2017].

Hennings, P. (1901a). Fungi Australiae occidentalis I. a cl. Diels et Pritzel collecti. *Hedwigia* 40 *Beib.*: 95–97.

Hennings, P. (1901b). Fungi Australiae occidentalis II. a cl. Pritzel collecti. *Hedwigia* 40: 352–355.

Hennings, P. (1903). Fungi australienses. *Hedwigia* 42 *Beib.*: 73–88.

Hiepko, P. (1987). The collections of the Botanical Museum Berlin-Dahlem (B) and their history. *Englera* 7: 219–252.

Makinson, R.O. (2000). *Grevillea*. *In*: Wilson, A. (ed.) *Flora of Australia* 17A: 1–460. (Australian Biological Resources Study: Canberra.)

McGillivray, D.J. & Makinson, R.O. (1993). *Grevillea, Proteaceae: a taxonomic revision*. (Melbourne University Press: Melbourne.)

McNeill, J., Barrie, F.R., Buck, W.R., Demoulin, V., Greuter, W., Hawksworth, D.L., Herendeen, P.S., Knapp, S., Marhold, K., Prado, J. & Prud'homme Van Reine, W.F. (2012). International Code of Nomenclature for algae, fungi, and plants. *Regnum vegetabile* 154.

Ostenfeld, C.E.H. (1916). Contributions to West Australian botany. I. *Dansk Botanisk Arkiv* 2(6): 1–44.

Ostenfeld, C.E.H. (1921). Contributions to West Australian Botany, part III: Additions and notes to the flora of extra-tropical W. Australia. *Biologiske meddelelser, Kongelige Danske Videnskabernes Selskab* 3: 1–144

Röpert D. (ed.) (2000–). *Digital specimen images at the Herbarium Berolinense*. http://search.biocase.org/bgbm/ [accessed 3 April 2017].

State Records Office of Western Australia (1900). Dr Ludwig Diels. Visit to Western Australia to study flora of the colony, asking for railway passes etc. AU WA S36 – cons1496 1900/1598.

Appendix 1. Transcript of a letter from Diels to Gardner suggesting an exchange of plant material (PERTH library archive).

Der Direktor
des Botanischen Gartens und Museums

Berlin – Dahlem, den 3ten September 1923
Königin Luisestrasse 6–8.

C.A. Gardner, Esq., Forest Department, Perth, W.A.

Dear Sir,

From the last issue of the P. & P. of the Roy. Soc. of W.A. I see that you are doing a good deal of work in the native flora of W.A. Being still much interested in the progress of W.A. botany, I venture to ask you whether you would care to start an exchange of W.A. herbarium specimens with me. I have got to offer a fairly good set of Pritzel's W.A. plants, if you would like to have this, please let me know. I would like to receive in return specimens of the regions not yet botanically exhausted, f.i. specimens (even small ones) of the species described by you. I shall be able, also, to compare doubtful forms with the good set of Drummonds plants of our herbarium.

I am, Dear Sir,
Yours truly,
Dr. L. Diels

Appendix 2. *Diels & Pritzel* joint collections held in C and PERTH indicating currently accepted taxon name, sheet number, corrected *Diels & Pritzel* collection number, date and WAM accession number. For some sheets the WAM accession number was inferred from an annotation on the lower left corner of the State Herbarium Western Australia label in cases where the original sheet had been discarded. Sheet numbers are from PERTH, except for the two C sheets which are prefixed with C.

Sheet No.	Taxon	Date	Collection No.	WAM Acc. No.
00111929	*Acacia aestivalis*	/01/1901	208	none
00720445	*Acacia alata* var. *alata*	/05/1901	306	150
00453609	*Acacia ancistrocarpa*	/04/1901	342	290
00115517	*Acacia barbinervis* subsp. *barbinervis*	/12/1900	252	154
00115096	*Acacia barbinervis* subsp. *barbinervis*	/12/1900	143	none
00115991	*Acacia baxteri*	/01/1901	178	170
00646768	*Acacia biflora*	/01/1901	226	160
00133418	*Acacia chrysocephala* (typical variant)	/05/1901	307	174
00670383	*Acacia cyclops*	/12/1900	224	none
00108081	*Acacia daphnifolia*	/06/1901	392	162
00107603	*Acacia daphnifolia*	/06/1901	*s.n.*	128
00683523	*Acacia dielsii*	/05/1901	290	157
00751480	*Acacia ericifolia*	/06/1901	336	156
00125202	*Acacia hastulata*	/07/1901	591	B83
00119067	*Acacia huegelii*	/12/1900	251	159
00590681	*Acacia lasiocalyx*	/08/1901	542	B41
00191582	*Acacia lasiocarpa* var. *lasiocarpa*	/11/1900	096	none
00100404	*Acacia meisneri*	/01/1901	239	161
00666319	*Acacia merinthophora*	/05/1901	288	164
00666300	*Acacia merinthophora*	/05/1901	*s.n.*	none
00108057	*Acacia microbotrya*	/05/1901	276	none
00192295	*Acacia myrtifolia*	/08/1901	576	B7
00199036	*Acacia obovata*	/03/1901	412	B1739
00611832	*Acacia oncinophylla* subsp. *oncinophylla*	/08/1901	600	B121
00607568	*Acacia oncinophylla* subsp. *oncinophylla*	/09/1901	476	B1740
00313505	*Acacia preissiana*	/12/1900	250	168
00708194	*Acacia ridleyana*	/03/1901	360	none
00707783	*Acacia ridleyana*	/03/1901	*s.n.*	155
00643599	*Acacia stenoptera*	/12/1900	009	152
00114065	*Acacia teretifolia*	/05/1901	310	153
01827901	*Acacia trachycarpa*	/04/1901	350	167
00138649	*Acacia truncata*	//1901	*s.n.*	none
00712493	*Acacia urophylla*	/05/1901	280	163

Sheet No.	Taxon	Date	Collection No.	WAM Acc. No.
00712507	*Acacia urophylla*	/05/1901	*s.n.*	none
00725188	*Acacia willdenowiana*	/06/1901	*s.n.*	none
00717894	*Acacia willdenowiana*	/06/1901	*s.n.*	none
01986643	*Acanthocarpus preissii*	/04/1901	358	728
03501779	*Actinotus omnifertilis*	/03/1901	381	324
03501965	*Actinotus omnifertilis*	/03/1901	*s.n.*	none
01714929	*Adenanthos barbiger*	/12/1900	*s.n.*	none
01720678	*Adenanthos meisneri*	/11/1900	070	583
01710222	*Adenanthos sericeus* subsp. *sericeus*	/01/1900	*s.n.*	582
03821498	*Adiantum aethiopicum*	/01/1901	201	750
02144743	*Allocasuarina acutivalvis*	/11/1900	037	654
01134914	*Allocasuarina grevilleoides*	/08/1901	527	B52
02215195	*Allocasuarina humilis*	/11/1900	089	655
02224038	*Allocasuarina thuyoides*	/05/1901	296	652
00310751	*Amphipogon debilis*	/12/1900	072	none
00311715	*Amphipogon laguroides* subsp. *laguroides*	/11/1900	108	741
00311618	*Amphipogon laguroides* subsp. *laguroides*	/12/1900	248	740
03195104	*Amyema miquelii*	/02/1901	371	335
03225925	*Amyema preissii*	/11/1900	030	336
02060531	*Anarthria laevis*	/05/1901	314	none
02060825	*Anarthria prolifera*	/07/1901	585	B89
02124777	*Andersonia caerulea*	/07/1901	not seen	not seen
02148013	*Andersonia heterophylla*	/09/1901	532	B1722
02125552	*Andersonia lehmanniana*	/05/1901	323	463
02129779	*Andersonia lehmanniana* subsp. *pubescens*	/05/1901	285	465
02126028	*Andersonia micrantha*	/01/1901	249	464
02361515	*Anthobolus foveolatus*	/01/1901	211	672
03662209	*Anthocercis genistoides*	/07/1901	593	B80
00677337	*Aotus cordifolia*	/01/1901	354	117
03301486	*Aphanopetalum clematideum*	/08/1901	543	B40
04387953	*Astartea affinis*	/11/1900	060	225
06118569	*Astartea scoparia*	/12/1900	173	none
02951800	*Astroloma serratifolium*	/05/1901	418	B1723
02952483	*Astroloma stomarrhena*	/05/1901	301	437
03363163	*Babingtonia grandiflora*	/09/1901	481	B1754
03378373	*Babingtonia urbana*	/03/1901	*s.n.*	221
01804731	*Banksia armata* var. *armata*	/05/1901	286	626
01806815	*Banksia carlinoides*	/03/1901	364	632

Sheet No.	Taxon	Date	Collection No.	WAM Acc. No.
01808729	*Banksia fraseri* var. *ashbyi*	/07/1901	430	B127
04385675	*Banksia nivea* subsp. *nivea*	/01/1901	183	618
01737732	*Banksia occidentalis*	/01/1901	262	616
01797913	*Banksia sessilis* var. *cygnorum*	/11/1900	073	none
01797603	*Banksia sessilis* var. *sessilis*	/05/1901	353	629
01757431	*Banksia sphaerocarpa* var. *sphaerocarpa*	/05/1901	284	638
01759175	*Banksia telmatiaea*	/06/1901	397	621
01759183	*Banksia telmatiaea*	//1901	411	B1725
01759183	*Banksia telmatiaea*	/05/1901	411	B1725
01791389	*Banksia tenuis* var. *tenuis*	/07/1901	590	B84
02346524	*Beaufortia aestiva*	/11/1901	506	B1752
02283859	*Beaufortia anisandra*	/01/1901	246	251
02290235	*Beaufortia purpurea*	/12/1900	193	none
02346206	*Beaufortia squarrosa*	/01/1901	253	250
03386171	*Billardiera fraseri*	/01/1901	202	22
02013738	*Blancoa canescens*	/08/1901	531	B50
00979589	*Boronia coerulescens* subsp. *spinescens*	/05/1901	287	65
00934852	*Boronia denticulata*	/01/1901	loan	loan
00938017	*Boronia dichotoma*	/12/1900	005	69
00948179	*Boronia heterophylla*	/09/1901	579	B4
00964018	*Boronia molloyae*	/09/1901	512	B75
00967750	*Boronia ovata*	/11/1900	031	66
02982609	*Brachyloma baxteri*	/03/1901	383	439
02985810	*Brachyloma mogin*	/05/1901	317	438
00413038	*Brachyscome perpusilla*	/08/1901	433	B124
01488090	*Byblis gigantea*	/12/1900	*s.n.*	184
00307491	*Caladenia nana* subsp. *nana*	/09/1901	*s.n.*	none
01594737	*Callistemon glaucus*	/01/1901	266	236
03901750	*Callitris acuminata*	/12/1900	023	675
03902110	*Callitris arenaria*	/05/1901	413	B27
03904482	*Callitris preissii*	/06/1901	356	674
01167243	*Calothamnus huegelii*	/05/1901	279	256
01146319	*Calothamnus pachystachyus*	/08/1901	553	B30
02330156	*Calothamnus quadrifidus* subsp. *quadrifidus*	/11/1900	052	257
02330571	*Calothamnus sanguineus*	/06/1901	333	none
02398036	*Calothamnus sanguineus*	/03/1901	373	none
02158760	*Calytrix asperula*	/01/1901	231	311

Sheet No.	Taxon	Date	Collection No.	WAM Acc. No.
03485900	*Calytrix flavescens*	/12/1900	163	209
03568598	*Calytrix fraseri*	/12/1900	154	215
03569683	*Calytrix glutinosa*	/08/1901	566	B17
01101072	*Calytrix pulchella*	/10/1901	487	B1755
03521249	*Calytrix strigosa*	/01/1901	209	213
01078011	*Calytrix sylvana*	/12/1901	515	B72
03521818	*Calytrix tenuiramea*	/03/1901	374	211
03521842	*Calytrix tenuiramea*	/03/1901	*s.n.*	none
03522687	*Calytrix violacea*	/10/1901	584	B131
03235130	*Capparis spinosa* subsp. *nummularia*	/04/1901	*s.n.*	none
03235025	*Capparis spinosa* subsp. *nummularia*	/04/1901	*s.n.*	015
03264750	*Cassytha flava*	/12/1900	228	none
03083233	*Cassytha glabella*	/12/1900	164	none
03265749	*Cassytha melantha*	/07/1901	587	none
03266257	*Cassytha pomiformis*	/12/1900	233	none
03266036	*Cassytha racemosa*	/11/1900	035	none
02234580	*Casuarina obesa*	/01/1901	176	656
03503755	*Centella asiatica*	/12/1900	147	325
03897745	*Centrolepis aristata*	/11/1900	106	733
03267024	*Cephalotus follicularis*	/01/1901	227	176
01989790	*Chamaexeros serra*	/10/1901	486	B120
01230263	*Chamelaucium micranthum*	/09/1901	not seen	not seen
02178052	*Chordifex sphacelatus*	/01/1901	181	732
02113384	*Choretrum glomeratum* var. *glomeratum*	/06/1901	389	667
00949663	*Chorilaena quercifolia*	/11/1901	498	B1730
04037219	*Comesperma confertum*	/11/1900	111	31
04038266	*Comesperma flavum*	/12/1900	103	none
04039394	*Comesperma nudiusculum*	/01/1901	264	33
04040627	*Comesperma scoparium*	/05/1901	loan	loan
04040538	*Comesperma scoparium*	/05/1901	273	29
04041399	*Comesperma virgatum*	/12/1900	220	34
02816172	*Commersonia borealis*	/07/1901	429	B128
01724401	*Conospermum flexuosum* subsp. *flexuosum*	/07/1901	462	B95
01724932	*Conospermum glumaceum*	/10/1901	568	B15
01728121	*Conospermum teretifolium*	/01/1901	244	586
02987295	*Conostephium pendulum*	/05/1901	311	441
02987872	*Conostephium preissii*	/12/1900	159	442
02049228	*Conostylis aculeata* subsp. *aculeata*	/12/1900	017	703

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02010623	*Conostylis androstemma*	/06/1901	*s.n.*	none
02011131	*Conostylis androstemma*	/06/1901	*s.n.*	695
02050234	*Conostylis aurea*	/11/1900	090	697
02053314	*Conostylis candicans* subsp. *candicans*	/11/1900	087	698
01079808	*Conostylis dielsii* subsp. *dielsii*	/08/1901	*s.n.*	B122
01080199	*Conostylis dielsii* subsp. *dielsii*	/08/1901	*s.n.*	?B52
02056348	*Conostylis juncea*	/11/1900	*s.n.*	702
02104911	*Conostylis setigera* subsp. *setigera*	/12/1900	207	701
02080850	*Conostylis setosa*	/11/1900	036	699
01521470	*Corchorus parviflorus*	/04/1901	344	58
01466852	*Corymbia hamersleyana*	/04/1901	349	none
01968165	*Corynotheca micrantha* var. *micrantha*	/12/1900	104	710
00433314	*Cotula coronopifolia*	/11/1900	109	354
02580888	*Cristonia biloba* subsp. *biloba*	/05/1901	274	none
02580926	*Cristonia biloba* subsp. *biloba*	/05/1901	*s.n.*	122
01501747	*Cryptandra arbutiflora* var. *arbutiflora*	/07/1901	460	B97
01512080	*Cryptandra mutila*	/07/1901	461	B96
01513575	*Cryptandra nutans*	/06/1901	326	81
01513567	*Cryptandra nutans*	/06/1901	*s.n.*	none
01100289	*Cryptandra polyclada* subsp. *polyclada*	/05/1901	292	none
01516310	*Cryptandra polyclada* subsp. *polyclada*	/05/1901	*s.n.*	none
01513729	*Cryptandra scoparia*	/06/1901	282	80
02184583	*Cyperus tenellus*	/11/1900	044	none
02547899	*Dampiera linearis*	/11/1900	046	429
02553120	*Dampiera stenostachya*	/10/1901	511	B76
01310976	*Darwinia diosmoides*	/01/1901	238	196
01075365	*Darwinia leiostyla*	/10/1901	577	B6
03922391	*Darwinia pauciflora*	/08/1901	425	B132
05147662	*Daviesia cordata*	/11/1900	*s.n.*	111
05200407	*Daviesia croniniana*	/11/1901	474	B1738
05147816	*Daviesia divaricata* subsp. *divaricata*	/11/1900	045	115
05195705	*Daviesia flexuosa*	/07/1901	575	B8
05209889	*Daviesia hakeoides* subsp. *subnuda*	/05/1901	294	116
05201721	*Daviesia hakeoides* subsp. *subnuda*	/05/1901	*s.n.*	none
05148758	*Daviesia nudiflora* subsp. *hirtella*	/06/1901	*s.n.*	none
05148731	*Daviesia nudiflora* subsp. *hirtella*	/06/1901	281	113
05201438	*Daviesia preissii*	/12/1900	191	114
05189462	*Daviesia rhombifolia*	/07/1901	444	B113

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02597276	*Diaspasis filifolia*	/01/1901	257	425
03666425	*Dicrastylis fulva*	/11/1901	502	B1732
01050605	*Dielsia stenostachya*	/05/1901	340	735
03920097	*Dioscorea hastifolia*	/05/1901	*s.n.*	707
03920100	*Dioscorea hastifolia*	/05/1901	278	none
00921165	*Diplolaena microcephala*	/07/1901	446	B112
01082086	*Dodonaea ericoides*	/03/1901	*s.n.*	none
01598813	*Dodonaea ericoides*	/03/1901	382	86
02412497	*Dodonaea viscosa* subsp. *angustissima*	/11/1900	032	284
00649104	*Drosera heterophylla*	/06/1901	*s.n.*	182
00647527	*Drosera heterophylla*	/06/1901	398	none
00659029	*Drosera huegelii*	/07/1901	443	B114
00663727	*Drosera macrantha* subsp. *macrantha*	/07/1901	456	B101
00666904	*Drosera microphylla*	/09/1901	534	B59
00957607	*Drummondita ericoides*	/06/1901	409	B1731
02338440	*Eremaea beaufortioides* var. *lachnosanthe* / *pauciflora* var. *lonchophylla*	/01/1901	149	259
03920666	*Eremaea pauciflora* var. *pauciflora*	/11/1900	067	258
03702626	*Eremophila alternifolia*	/10/1901	472	B104
02403994	*Eremophila glabra* subsp. *chlorella*	/08/1901	526	B57
03793443	*Eremophila ionantha*	/11/1900	066	521
03852067	*Eremophila maculata* subsp. *brevifolia*	/08/1901	563	B20
03855228	*Eremophila oldfieldii* subsp. *oldfieldii*	/06/1901	335	529
00506249	*Erymophyllum ramosum* subsp. *ramosum*	/11/1900	084	387
02940019	*Eryngium pinnatifidum*	/11/1900	loan	loan
01328441	*Eucalyptus camaldulensis* subsp. *refulgens*	/04/1901	347	276
01324837	*Eucalyptus decipiens*	/05/1901	300	none
01704877	*Eucalyptus decurva*	/07/1901	450	B107
01148168	*Eucalyptus dissimulata* subsp. *dissimulata*	/01/1901	185	274
01336509	*Eucalyptus diversicolor*	/03/1901	380	265
01352458	*Eucalyptus erythronema* subsp. *inornata*	/05/1901	315	264
01355090	*Eucalyptus eudesmioides*	/06/1901	327	none
01339354	*Eucalyptus forrestiana*	/11/1901	479	B1745
01350536	*Eucalyptus gomphocephala*	/03/1901	377	270
01386352	*Eucalyptus horistes*	/07/1901	592	B82
01421603	*Eucalyptus lehmannii* subsp. *lehmannii*	/05/1901	loan	loan
01410563	*Eucalyptus loxophleba* subsp. *loxophleba*	/05/1901	359	262
01391224	*Eucalyptus marginata* subsp. *marginata*	/03/1901	372	none

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01391291	*Eucalyptus marginata* subsp. *marginata*	/11/1900	019	none
01472968	*Eucalyptus nuda*	/05/1901	loan	loan
01361821	*Eucalyptus occidentalis*	/06/1901	388	266
01381784	*Eucalyptus oldfieldii*	/06/1901	394	none
01463063	*Eucalyptus pyriformis*	/09/1901	597	B138
01536222	*Eucalyptus rudis*	/02/1901	369	313
01473638	*Eucalyptus rudis*	/02/1901	*s.n.*	none
01471015	*Eucalyptus salmonophloia*	/06/1901	519	B1742
01457918	*Eucalyptus salmonophloia*	/05/1901	293	261
01409166	*Eucalyptus subangusta* subsp. *subangusta*	/03/1901	378	263
01460307	*Eucalyptus torquata*	/11/1901	515	none
01181599	*Eucalyptus victrix*	/04/1901	345	none
01473824	*Eucalyptus wandoo* subsp. *wandoo*	/08/1901	408	B1743
01473395	*Eucalyptus wandoo* subsp. *wandoo*	/02/1901	370	320
00699071	*Euchilopsis linearis*	/12/1900	156	109
02364883	*Exocarpos odoratus*	/03/1901	*s.n.*	671
02364808	*Exocarpos odoratus*	/03/1901	*s.n.*	none
02366649	*Exocarpos sparteus*	/02/1901	363	673
02366738	*Exocarpos sparteus*	/02/1901	*s.n.*	none
04157184	*Ficus brachypoda*	/04/1901	387	651
08418217	*Frankenia glomerata*	/11/1901	404	B1728
01675877	*Franklandia fucifolia*	/01/1901	186	589
02741725	*Gastrolobium celsianum*	/08/1901	558	B25
02820102	*Gastrolobium dilatatum*	/12/1900	166	90
02906317	*Gastrolobium ebracteolatum*	/12/1900	012	91
02891867	*Gastrolobium obovatum*	/08/1901	565	B19
02783460	*Gastrolobium velutinum*	/10/1901	484	B1735
02784068	*Gastrolobium villosum*	/07/1901	595	none
03470482	*Glischrocaryon aureum*	/11/1900	076	185
00417483	*Gnephosis tenuissima*	/11/1900	064	357
02831767	*Gompholobium polymorphum*	/11/1900	*s.n.*	none
03492095	*Gonocarpus benthamii* subsp. *benthamii*	/01/1901	200	190
01109537	*Gonocarpus cordiger*	/12/1900	235	107
01067060	*Gonocarpus* sp.	/12/1900	162	188
02601249	*Goodenia coerulea*	/12/1900	001	481
02603578	*Goodenia eatoniana*	/01/1901	199	416
02604388	*Goodenia fasciculata*	/11/1900	051	422

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02604566	*Goodenia pulchella* subsp. Coastal Plain A (M. Hislop 634)	/12/1900	002	415
01761765	*Grevillea argyrophylla*	/08/1901	549	none
01762850	*Grevillea biformis* subsp. *biformis*	/01/1901	142	none
01763563	*Grevillea bipinnatifida* subsp. *bipinnatifida*	/12/1900	*s.n.*	none
01850741	*Grevillea biternata*	/06/1901	loan	loan
01111108	*Grevillea candolleana*	/08/1901	571	none
01815512	*Grevillea diversifolia* subsp. *diversifolia*	/02/1901	366	600
01801600	*Grevillea excelsior*	/10/1901	414	none
02219042	*Grevillea fasciculata*	/05/1901	316	605
02219875	*Grevillea hakeoides* subsp. *stenophylla*	/06/1901	328	598
02072726	*Grevillea integrifolia*	/05/1901	299	614
01803603	*Grevillea manglesii* subsp. *manglesii*	/11/1900	049	none
01961616	*Grevillea nematophylla*	/11/1900	039	none
01849646	*Grevillea occidentalis*	/01/1901	221	597
02415364	*Grevillea pilulifera*	/05/1901	351	none
01068687	*Grevillea pimeleoides*	/08/1901	432	B125
01938843	*Grevillea preissii* subsp. *preissii*	/06/1901	275	none
02439093	*Grevillea synapheae* subsp. *synapheae*	/08/1901	596	none
01937766	*Grevillea trifida*	/01/1901	440	B117
02414694	*Grevillea umbellulata*	/08/1901	426	B133
02407876	*Grevillea vestita* subsp. *vestita*	/08/1901	loan	loan
02696738	*Guichenotia micrantha*	/08/1901	541	B42
03293416	*Gyrostemon ramulosus*	/08/1901	561	B22
06185894	*Hakea circumalata*	/09/1901	422	none
06161111	*Hakea costata*	/03/1901	365	631
06125107	*Hakea cristata*	/05/1901	*s.n.*	628
06123449	*Hakea erinacea*	/05/1901	309	627
06160565	*Hakea ferruginea*	/07/1901	589	B85
06157041	*Hakea ferruginea*	/01/1901	240	none
06160026	*Hakea incrassata*	/07/1901	455	B102
06189024	*Hakea lasiantha*	/07/1901	588	B86
06158234	*Hakea linearis*	/01/1901	268	613
06122809	*Hakea marginata*	/06/1901	*s.n.*	none
06123074	*Hakea marginata*	/06/1901	390	612
06308139	*Hakea myrtoides*	/08/1901	598	B135
06291406	*Hakea pycnoneura*	/06/1901	337	630
02630303	*Halgania anagalloides*	/01/1901	272	506

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01602101	*Halgania argyrophylla*	/11/1901	507	B54
02636603	*Halgania cyanea* var. Allambi Stn (B.W. Strong 676)	/10/1901	415	B66
02634082	*Halgania sericiflora*	/11/1901	405	B51
02879476	*Hardenbergia comptoniana*	/09/1901	464	B94
02013916	*Hemiandra pungens*	/11/1900	loan	loan
02014718	*Hemiandra pungens*	/01/1901	loan	loan
03737497	*Hemiphora bartlingii*	/01/1901	141	531
01968734	*Hensmania turbinata*	/12/1900	155	725
03043215	*Hibbertia aurea*	/09/1901	540	B62
03068935	*Hibbertia conspicua*	/11/1901	503	B63
03028305	*Hibbertia cunninghamii*	/07/1901	451	none
03093123	*Hibbertia diamesogenos*	/12/1900	014	none
03038017	*Hibbertia nymphaea*	/02/1901	367	none
03038092	*Hibbertia nymphaea*	/02/1901	*s.n.*	007
03095096	*Hibbertia rupicola*	/12/1900	026	307
01278851	*Hibbertia silvestris*	/01/1901	198	309
03108015	*Hibbertia stellaris*	/12/1900	059	386
03107736	*Hibbertia stellaris*	/12/1900	*s.n.*	305
03538044	*Homalosciadium homalocarpum*	/12/1900	165	332
02802783	*Hovea chorizemifolia*	/05/1901	322	123
02803879	*Hovea elliptica*	/09/1901	494	B1736
02804573	*Hovea pungens*	/09/1901	493	B1737
02804611	*Hovea pungens*	/11/1900	094	none
02806215	*Hovea trisperma*	/05/1901	303	124
03370933	*Hybanthus aurantiacus*	/04/1901	348	none
03339440	*Hybanthus aurantiacus*	/04/1901	*s.n.*	18
03374041	*Hybanthus floribundus* subsp. *floribundus*	/06/1901	400	16
03374645	*Hybanthus floribundus* subsp. *floribundus*	/06/1901	*s.n.*	none
02353210	*Hypocalymma strictum*	/01/1901	263	227
03363686	*Isopogon cuneatus*	/07/1901	463	B93
03439097	*Isopogon divergens*	/08/1901	431	B126
03418731	*Isopogon drummondii*	/02/1901	407	B1724
03364607	*Isopogon dubius*	/08/1901	569	B14
04229460	*Isopogon spathulatus*	/05/1901	297	580
03429431	*Isopogon teretifolius* subsp. *teretifolius*	/08/1901	528	B55
01884840	*Jacksonia alata*	/08/1901	467	B90
01910221	*Jacksonia floribunda*	/12/1900	171	103

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01911686	*Jacksonia furcellata*	/12/1900	007	104
01914634	*Jacksonia spinosa*	/01/1901	258	102
01916815	*Jacksonia sternbergiana*	/12/1900	028	none
01969684	*Johnsonia pubescens* subsp. *pubescens*	/11/1900	105	none
02872897	*Kennedia microphylla*	/09/1901	582	none
00443654	*Lagenophora huegelii*	/12/1900	175	350
00444006	*Lagenophora huegelii*	/08/1901	434	none
02703297	*Lasiopetalum cordifolium* subsp. *cordifolium*	/09/1901	581	B2
02759128	*Lasiopetalum monticola*	/09/1901	590	B3
01078720	*Lasiopetalum oldfieldii* subsp. *oldfieldii*	/11/1901	403	B43
02008076	*Laxmannia sessiliflora* subsp. *sessiliflora*	/06/1901	330	717
06489591	*Laxmannia squarrosa*	/11/1900	011	722
02202476	*Lechenaultia expansa*	/12/1900	006	411
02203103	*Lechenaultia floribunda*	/11/1900	114	412
02441993	*Leptomeria cunninghamii*	/11/1900	040	664
02442981	*Leptomeria lehmannii*	/05/1901	320	666
02443341	*Leptomeria preissiana*	/11/1900	080	663
02444453	*Leptomeria scrobiculata*	/05/1901	302	665
02445433	*Leptomeria squarrulosa*	/01/1901	234	668
02401738	*Leptospermum erubescens*	/08/1901	570	B13
02401924	*Leptospermum fastigiatum*	/10/1901	471	B1753
03000176	*Leucopogon australis*	/08/1901	548	B53
02990245	*Leucopogon conostephioides*	/05/1901	355	458
02955016	*Leucopogon dielsianus*	/05/1901	405	B1718
02955040	*Leucopogon dielsianus*	/05/1901	338	none
02955075	*Leucopogon dielsianus*	/05/1901	*s.n.*	452
04161718	*Leucopogon distans*	/07/1901	486	B1720
05700744	*Leucopogon glabellus*	/01/1901	261	445
07688954	*Leucopogon gracillimus*	/07/1901	441	B116
02991284	*Leucopogon hamulosus*	/06/1901	395	456
C10010899	*Leucopogon hamulosus*	/06/1901	*s.n.*	none
02991799	*Leucopogon hispidus*	/06/1901	334	none
C10010901	*Leucopogon hispidus*	/06/1901	*s.n.*	460
02992914	*Leucopogon nutans*	/05/1901	339	none
01140051	*Leucopogon oliganthus*	/06/1901	402	none
01140078	*Leucopogon oliganthus*	/06/1901	*s.n.*	459
03007103	*Leucopogon oppositifolius*	/05/1901	318	450

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03007898	*Leucopogon oxycedrus*	/05/1901	319	490
08121303	*Leucopogon parviflorus*	/04/1901	357	none
03009874	*Leucopogon pendulus*	/03/1901	386	none
02994488	*Leucopogon propinquus*	/02/1901	362	453
02997096	*Leucopogon pulchellus*	/07/1901	549	B81
08153493	*Leucopogon* sp.	/05/1901	291	none
08153515	*Leucopogon* sp.	/08/1901	557	B26
02989832	*Leucopogon* sp. Northern ciliate (R. Davis 3393)	/06/1901	418	B1721
07880405	*Leucopogon squarrosus* subsp. *squarrosus*	/05/1901	321	447
04394380	*Leucopogon strictus*	/07/1901	458	B99
03039331	*Leucopogon tamariscinus*	/05/1901	298	449
08236364	*Leucopogon tenuis*	/12/1900	194	457
07579047	*Leucopogon tetragonus*	/07/1901	482	B1719
01212028	*Leucopogon verticillatus*	/08/1901	550	B33
02990563	*Leucopogon* aff. *conostephioides*	/06/1901	*s.n.*	489
02768844	*Levenhookia preissii*	/12/1900	160	409
03831469	*Lindsaea linearis*	/01/1901	*s.n.*	749
03831396	*Lindsaea linearis*	/01/1901	267	none
03575993	*Liparophyllum capitatum*	/12/1900	015	502
02015900	*Lomandra micrantha* subsp. *micrantha*	/06/1901	452	B105
02018632	*Lomandra preissii*	/05/1901	352	727
01189565	*Lotus australis*	/08/1901	564	B18
03565351	*Malleostemon roseus*	/10/1901	517	B70
03267253	*Marianthus coeruleopunctatus*	/11/1900	025	20
05003105	*Marianthus ringens*	/09/1901	489	B46
03384128	*Marianthus tenuis*	/06/1901	454	B103
03834034	*Marsilea exarata*	/07/1901	447	B110
01162586	*Meionectes tenuifolia*	/12/1900	206	189
03526801	*Melaleuca cardiophylla*	/01/1901	213	240
03599523	*Melaleuca huegelii* subsp. *huegelii*	/11/1900	047	245
03590593	*Melaleuca lateritia*	/12/1900	146	314
01578766	*Melaleuca leptospermoides*	/05/1901	416	B1757
01585649	*Melaleuca megacephala*	/08/1901	537	B45
03221210	*Melaleuca pauciflora*	/01/1901	157	249
03606198	*Melaleuca preissiana*	/12/1900	145	247
03606465	*Melaleuca radula*	/08/1901	546	B37
03608174	*Melaleuca rhaphiophylla*	/11/1900	043	1587

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01577123	*Melaleuca seriata*	/12/1900	077	none
01577077	*Melaleuca seriata*	/12/1900	148	241
01606565	*Melaleuca spathulata*	/10/1901	485	B1756
01570242	*Melaleuca striata*	/01/1901	150	246
01579908	*Melaleuca systena*	/11/1900	*s.n.*	244
03609987	*Melaleuca thyoides*	/12/1901	514	B71
01576054	*Melaleuca trichophylla*	/12/1900	190	239
01576011	*Melaleuca trichophylla*	/11/1900	092	none
00986003	*Microcybe multiflora* subsp. *multiflora*	/11/1901	419	B1729
00510548	*Millotia myosotidifolia*	/09/1901	496	B118
05618169	*Monotaxis grandiflora* var. *grandiflora*	/12/1900	022	645
04332024	*Muehlenbeckia polybotrya*	/06/1901	393	639
03881687	*Myoporum montanum*	/06/1901	329	519
03881695	*Myoporum montanum*	/06/1901	*s.n.*	none
03534243	*Myriophyllum tillaeoides*	/12/1900	*s.n.*	178
03065421	*Needhamiella pumilio*	/09/1901	465	B92
01607839	*Newcastelia insignis*	/10/1901	480	none
03186490	*Olax benthamiana* (typical variant)	/08/1901	518	B69
03191060	*Olax phyllanthi*	/01/1901	229	73
00529133	*Olearia paucidentata*	/05/1901	*s.n.*	348
00528927	*Olearia paucidentata*	/05/1901	324	none
00449628	*Olearia* sp. Eremicola (Diels & Pritzel s.n. PERTH 00449628)	/05/1901	304	none
03841871	*Opercularia echinocephala*	/12/1900	167	340
03842940	*Opercularia spermacocea*	/08/1901	524	B60
03843343	*Opercularia vaginata*	/12/1900	016	342
03843327	*Opercularia vaginata*	/01/1901	271	341
01654136	*Orianthera campanulata*	/12/1900	203	500
01676261	*Orianthera spermacocea*	/11/1901	478	B95
03575632	*Ornduffia albiflora*	/11/1900	098	503
00441562	*Ozothamnus lepidophyllus*	/01/1901	179	373
03541940	*Pentapeltis peltigera*	/12/1900	*s.n.*	330
01597817	*Pentapeltis silvatica*	/02/1901	368	none
02974878	*Pericalymma crassipes*	/02/1901	*s.n.*	none
02974827	*Pericalymma crassipes*	/02/1901	391	none
02581280	*Pericalymma ellipticum* var. *floridum*	/12/1900	*s.n.*	233
04173007	*Persoonia elliptica*	/11/1900	024	590
04094786	*Persoonia longifolia*	/01/1901	255	592

Sheet No.	Taxon	Date	Collection No.	WAM Acc. No.
04173740	*Persoonia saccata*	/12/1900	195	591
03440400	*Petrophile biloba*	/02/1901	245	none
01920847	*Petrophile brevifolia*	/08/1901	573	B10
03431584	*Petrophile chrysantha*	/08/1901	567	B16
01866265	*Petrophile linearis*	/11/1900	054	none
01767860	*Petrophile macrostachya*	/12/1900	232	579
03431916	*Petrophile megalostegia*	/09/1901	602	B1726
03440206	*Petrophile scabriuscula*	/08/1901	427	B130
01858912	*Petrophile shuttleworthiana*	/08/1901	555	B28
00894680	*Philotheca nodiflora* subsp. *lasiocalyx*	/10/1901	420	B136
01084038	*Phlebocarya filifolia*	/11/1900	088	706
01003925	*Phyllangium paradoxum*	/11/1900	112	501
01627996	*Phyllanthus calycinus*	/12/1900	loan	loan
00694371	*Phyllota barbata*	/01/1901	241	118
02504782	*Pileanthus peduncularis* subsp. *peduncularis*	/10/1901	417	B67
03406644	*Pimelea argentea*	/07/1901	586	B88
03409082	*Pimelea brevistyla* subsp. *brevistyla*	/09/1901	536	B47
03444007	*Pimelea floribunda*	/08/1901	551	B32
03445305	*Pimelea imbricata* var. *major*	/12/1900	225	660
03446743	*Pimelea imbricata* var. *piligera*	/11/1900	*s.n.*	659
03446751	*Pimelea imbricata* var. *piligera*	/11/1900	075	none
03472779	*Pimelea rosea* subsp. *rosea*	/11/1900	102	658
03475034	*Pimelea suaveolens* subsp. *suaveolens*	/07/1901	445	B111
03476693	*Pimelea sylvestris*	/11/1900	079	657
00424196	*Pithocarpa cordata*	/02/1901	376	371
00535591	*Pithocarpa pulchella* var. *melanostigma*	/02/1901	269	397
03819329	*Plantago exilis*	/10/1901	490	B56
00547298	*Podolepis capillaris*	/11/1900	041	368
00537950	*Podolepis gracilis*	/11/1900	099	369
00546666	*Podolepis nutans*	/12/1900	013	370
00539422	*Pogonolepis stricta*	/11/1900	065	none
00245259	*Praecoxanthus aphyllus*	31/03/1901	*s.n.*	none
00244341	*Praecoxanthus aphyllus*	/03/1901	*s.n.*	none
00285145	*Prasophyllum cucullatum*	/10/1901	*s.n.*	none
00785970	*Prasophyllum cyphochilum*	04/10/1901	*s.n.*	none
00216526	*Ptilotus declinatus*	/11/1900	034	566
00211516	*Ptilotus drummondii* var. *drummondii*	/11/1900	053	568

Sheet No.	Taxon	Date	Collection No.	WAM Acc. No.
00216224	*Ptilotus gaudichaudii* subsp. *gaudichaudii*	/12/1900	*s.n.*	563
00220035	*Ptilotus manglesii*	/11/1900	068	565
00226785	*Ptilotus stirlingii* subsp. *stirlingii*	/11/1900	095	567
03741362	*Quoya paniculata*	/08/1901	438	B119
03770583	*Quoya verbascina*	/11/1901	501	B1733
01036122	*Regelia ciliata*	/01/1901	180	312
02127555	*Regelia ciliata*	/01/1901	254	315
01567128	*Rhagodia latifolia* subsp. *recta*	/01/1901	212	542
00436852	*Rhodanthe chlorocephala* subsp. *rosea*	/08/1901	428	B129
06845916	*Ricinocarpos stylosus*	/11/1901	470	B68
03536726	*Samolus junceus*	/12/1900	008	none
02446405	*Santalum acuminatum*	/11/1900	010	670
02343061	*Scaevola calliptera*	/11/1900	078	423
02649837	*Scaevola crassifolia*	/11/1900	021	419
02737906	*Scaevola sericophylla*	/01/1901	215	424
03768473	*Schizaea fistulosa*	/01/1901	259	753
03894924	*Scholtzia involucrata*	/12/1900	169	218
04064607	*Scholtzia umbellifera*	/01/1901	210	220
04389603	*Selaginella gracillima*	/11/1960	113	746
02699435	*Seringia hermanniifolia*	/01/1901	218	52
00557773	*Siloxerus humifusus*	/11/1900	093	358
02921383	*Sphaerolobium medium*	/08/1901	572	B11
03027651	*Sphenotoma gracilis*	/12/1900	197	none
03027724	*Sphenotoma gracilis*	/01/1901	230	486
00595314	*Spinifex longifolius*	/04/1901	346	743
01519131	*Spyridium globulosum*	/06/1901	283	79
05690102	*Stachystemon vermicularis*	/05/1901	312	none
01704818	*Stirlingia simplex*	/09/1901	466	B91
02943301	*Stylidium crossocephalum*	/09/1901	520	B65
02943646	*Stylidium dichotomum*	/12/1900	018	495
02943778	*Stylidium dichotomum*	/12/1900	205	480
03049132	*Stylidium miniatum*	/08/1901	469	B32
02955768	*Stylidium neurophyllum*	/11/1900	020	408
03162540	*Stylidium nymphaeum*	/01/1901	247	407
02959380	*Stylidium thesioides*	/12/1900	048	404
02694344	*Stylidium utricularioides*	/11/1900	069	402
03301567	*Stylobasium australe*	/08/1901	538	B44
03302393	*Stylobasium spathulatum*	/09/1901	513	B74

Sheet No.	Taxon	Date	Collection No.	WAM Acc. No.
02999331	*Styphelia tenuiflora*	/05/1901	313	436
04263308	*Synaphea* sp. Serpentine (G.R. Brand 103)	/12/1900	not seen	not seen
02006693	*Synaphea spinulosa* subsp. *spinulosa*	/11/1900	055	none
04035062	*Taxandria fragrans*	/03/1901	375	230
04035070	*Taxandria fragrans*	/03/1901	*s.n.*	none
03885895	*Taxandria linearifolia*	/11/1900	091	316
02593378	*Tecticornia* sp.	/12/1900	158	none
03561178	*Terminalia circumalata*	/04/1901	341	none
03295478	*Tersonia cyathiflora*	/08/1901	405	B58
02963744	*Tetratheca hirsuta*	/12/1900	192	299
02963604	*Tetratheca hirsuta*	/11/1900	081	300
02963183	*Tetratheca hirsuta*	/08/1901	547	B36
02705486	*Thomasia foliosa*	/05/1901	*s.n.*	none
02705478	*Thomasia foliosa*	/05/1901	325	53
02706032	*Thomasia grandiflora*	/07/1901	554	B29
02707578	*Thomasia pauciflora*	/01/1901	214	54
01132210	*Thomasia solanacea*	/11/1901	499	B39
02709783	*Thomasia triphylla*	/09/1901	535	B48
04365607	*Thryptomene nitida*	/06/1901	*s.n.*	none
02188589	*Thryptomene nitida*	/06/1901	332	224
02196115	*Thryptomene saxicola*	/07/1901	499	B108
03015599	*Thysanotus dichotomus*	/12/1900	236	720
03579867	*Trachymene coerulea* subsp. *coerulea*	/12/1900	loan	loan
02861348	*Tremandra stelligera*	/01/1901	265	none
03110478	*Tricoryne elatior*	/12/1900	*s.n.*	719
03894169	*Triglochin striata*	/02/1901	361	731
01132512	*Trymalium angustifolium*	/05/1901	295	77
01518437	*Trymalium litorale*	/07/1901	448	B109
02767554	*Verreauxia reinwardtii*	/12/1900	174	426
01895729	*Verticordia acerosa* var. *preissii*	/10/1901	473	B1750
02063220	*Verticordia chrysostachys* var. *chrysostachys*	/11/1901	508	B1751
02061392	*Verticordia densiflora* var. *densiflora*	/12/1900	168	199
02061376	*Verticordia densiflora* var. *densiflora*	/12/1900	153	none
02062844	*Verticordia densiflora* var. *stelluligera*	/11/1901	504	B1748
02166593	*Verticordia grandis*	/01/1901	*s.n.*	none
02163292	*Verticordia habrantha*	/09/1901	406	B1746
02208628	*Verticordia huegelii* var. *huegelii*	/09/1901	510	B77

Sheet No.	Taxon	Date	Collection No.	WAM Acc. No.
01946714	*Verticordia lehmannii*	/03/1901	385	202
01057200	*Verticordia lindleyi* subsp. *lindleyi*	/12/1900	*s.n.*	204
02359561	*Verticordia nitens*	/12/1900	152	206
02359928	*Verticordia oculata*	/11/1901	500	B1747
01026518	*Verticordia plumosa* var. *ananeotes*	/12/1900	243	200
02681943	*Verticordia plumosa* var. *plumosa*	/11/1900	074	318
02686627	*Verticordia serrata* var. *ciliata*	/10/1901	477	none
01401882	*Verticordia wonganensis*	/01/1901	237	none
02851385	*Viminaria juncea*	/11/1900	042	none
00624322	*Waitzia suaveolens* var. *suaveolens*	/11/1900	056	378
03731014	*Westringia cephalantha*	/10/1901	521	B64
02020955	*Xanthorrhoea gracilis*	/12/1900	063	726
03619109	*Xanthosia atkinsoniana*	/12/1900	151	329
03619923	*Xanthosia ciliata*	/12/1900	223	331
01713019	*Xylomelum angustifolium*	/01/1901	140	593

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SHORT COMMUNICATION

Hydrocotyle spinulifera and *H. dimorphocarpa* (Araliaceae), two new Western Australian species with dimorphic mericarps

Two new species of *Hydrocotyle* L. from the Moora–Geraldton–Paynes Find area of Western Australia are described and illustrated herein. Both species differ from all other members of the genus in having highly asymmetric fruits with one mericarp markedly winged and the other wingless. Their close relationship with the rare Western Australian species *H. muriculata* Turcz. is discussed. Both species have conservation priority.

Hydrocotyle spinulifera A.J.Perkins, *sp. nov.*

Type: Marchagee Nature Reserve, Western Australia [precise locality withheld for conservation reasons], 7 October 1997, *B.P. Richardson* BPR 0022 (*holo*: PERTH 04968751; *iso*: AD, CANB, MEL, NSW).

Hydrocotyle coorowensis H.Eichler ms, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 13 September 2017].

Hydrocotyle sp. Coorowensis (P.G. Wilson 12580), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 13 September 2017].

Annual herbs consisting of a basal rosette of leaves and branched stems bearing leaves and umbellate inflorescences, 1–4 cm high, 2–10 cm wide. *Stems* decumbent to ascending, pale green to reddish green, terete, glabrous. *Stipules* white, lanceolate to linear-lanceolate, 1.0–4.0 mm long, 0.5–2.5 mm wide, membranous, translucent, irregularly fringed to ciliate along margins. *Petioles* 10–40 mm long, glabrous or occasionally with a skirt of wiry white hairs at the base of the leaf lamina. *Leaf blades* simple, dorsiventral, carnose, rhombic to trilobed in juvenile leaves, trilobed to pedately lobed in mature leaves, 4–20 mm long, 4–28 mm wide; adaxial surface uniformly green or pale reddish green, glabrous; abaxial surface pale green, glabrous (or rarely with a few scattered, simple, antrorse hairs). *Leaf margins* toothed; teeth obtuse to acute. *Median leaf lobes* ovate to obovate, 4–16 mm long, 2–11 mm wide, with 1–6 marginal teeth. *Lateral leaf lobes* 3–17 mm long, 3–16 mm wide, with 3–9 marginal teeth, incised into two asymmetrical lobules in pedate leaves; leaf sinuses 10–70% of lateral lobe length. *Inflorescences* leaf-opposed, simple umbels, anthesis centripetal, 12–30-flowered, 5–8 mm wide, the first umbel to flower and fruit borne centrally on a peduncle distinctly shorter than rosette leaves, with successive umbels borne along stems radiating out from the basal rosette. *Peduncles* terete, shorter than subtending leaves, 1–12 mm long, glabrous. *Involucral bracts* absent. *Pedicels* light green, subterete, somewhat flattened, recurved in outermost flowers, erect in innermost flowers, 1–2 mm long, arranged in three whorls; outermost ones basally connate (joined to neighbouring pedicels by a membranous flap of tissue), with 1–3 wiry pendulous hairs (predominantly simple, rarely bifid) near attachment to the peduncle. *Flowers* all hermaphrodite, protandrous. *Sepals* 5, filiform, setose, 0.6–0.8 mm long. *Petals* 5, predominantly cream with pale pink to crimson on the abaxial surface (towards the apex), ovate, 0.5–0.7 mm long, 0.3–0.4 mm wide. *Filaments* white, 0.6–1.0 mm long. *Anthers* light cream, 0.2–0.3 mm long. *Ovaries* pale green

https://florabase.dpaw.wa.gov.au/nuytsia/
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at anthesis, bilaterally flattened, orbicular, minutely spinose along dorsal ribs. *Fruiting pedicels* erect to incurved, 1.0–4.0 mm long, with outermost ones distinctly longer than inner ones. *Schizocarps* bilaterally flattened, bearing dimorphic mericarps; mericarps light green turning light creamy brown on outer (flattened) margins and light orange-brown (centrally) at maturity; commissure 90% the length of inner mericarp and 30–40% of the outer mericarp. *Outer mericarps* markedly winged (between the dorsal and lateral ribs), 2.0–2.7 mm long, 1.5–2.0 mm wide; dorsal rib distinctly spinulose (4–12 small spines) along margins, spines 0.05–0.40 mm long; lateral ribs prominently raised; outer surface of (raised) lateral ribs convex, papillate, minutely colliculate; surface between (raised) lateral ribs and median ribs deeply concave, with 3–5 prominently raised ridges running perpendicular to the commissure, occasionally papillate, minutely colliculate. *Inner mericarps* 0.9–1.2 mm long, 0.9–1.1 mm wide, morphologically similar to outer mericarps except for the lack of a wing. *Carpophores* persistent, acerose, 0.7–1.0 mm long. *Fruiting styles* swollen at the base, 0.9–1.1 mm long, reflexed. *Cotyledons* narrowly elliptic to oblong in the seedlings. (Figure 1A–C)

Diagnostic features. *Hydrocotyle spinulifera* can be distinguished from all other taxa in *Hydrocotyle* by following combination of characters: annual herbs with the first umbel to flower and fruit borne (centrally) amongst the leaves of the basal rosette on a peduncle distinctly shorter than rosette leaves; pedicels subterete (somewhat flattened), outermost pedicels basally connate (joined by a membranous flap of tissue); sepals filiform, setose; ovaries and mature mericarps spinose along dorsal ribs; mature schizocarps bearing dimorphic mericarps in which the outer mericarp is distinctly winged and the other wingless; carpophores persistent, acerose.

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 7 Oct. 2009, *W. Chow* BENT 34 Q 1 58 (PERTH); 23 Nov. 2003, *A. Crawford* 469 (PERTH); 11 Sep. 1985, *Hj. Eichler* 23666 (CANB); 11 Sep. 1985, *Hj. Eichler* 23669 (CANB); 11 Sep. 1985, *Hj. Eichler* 23674 (CANB); 12 Sep. 1985, *Hj. Eichler* 23683 (CANB); 14 Sep. 1991, *E.A. Griffin* 6554 (PERTH); 20 Sep. 2000, *S. Hamilton-Brown* RG 34 (PERTH); 20 Sep. 2000, *S. Hamilton-Brown s.n.* (PERTH 06454895); 25 Sep. 2001, *S. Hamilton-Brown s.n.* (PERTH 06454771); 11 Aug. 1999, *G.J. Keighery & N. Gibson* 4911 (PERTH); 21 Sep. 1999, *M.N. Lyons & S.D. Lyons* 4112 (PERTH); 26 Sep. 1999, *M.N. Lyons & S.D. Lyons* 4889 (PERTH); 16 Sep. 2000, *M.N. Lyons & S.D. Lyons* 4589 (PERTH); 17 Sep. 2000, *M.N. Lyons & S.D. Lyons* 4715 (PERTH); 5 Oct. 2000, *M.N. Lyons & S.D. Lyons* 4727 (PERTH); 20 Oct. 2000, *M.N. Lyons & S.D. Lyons* 4888 (PERTH); 15 Sep. 2005, *A.J. Perkins s.n.* (NSW, PERTH 08029229, SYD); 8 Oct. 2017, *A.J. Perkins* AJP-WA 138 (PERTH); 27 Oct. 2017, *A.J. Perkins* AJP-WA 145 (PERTH); 24 Oct. 1983, *P.S. Short* 2200 (CANB, MEL); 22 Sep. 1987, *P.G. Wilson* 12580 (PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from August to November.

Distribution and habitat. Extends from near Moora north to Three Springs and further north-east to beyond Morawa (Figure 2). Plants grow along moist margins of seasonal wetlands, freshwater and saline lakes in this region, often sheltered under small shrubs of *Tecticornia* and *Frankenia* spp. and in association with *Casuarina obesa* or *Melaleuca* spp. (Figure 1D).

Conservation status. *Hydrocotyle spinulifera* is listed by Smith and Jones (2018) as Priority Three under Conservation Codes for Western Australian Flora, under the name *Hydrocotyle* sp. Coorowensis (P.G. Wilson 12580). *Hydrocotyle spinulifera* is known from 13 general localities scattered over a distance of *c.* 175 km, including several nature reserves.

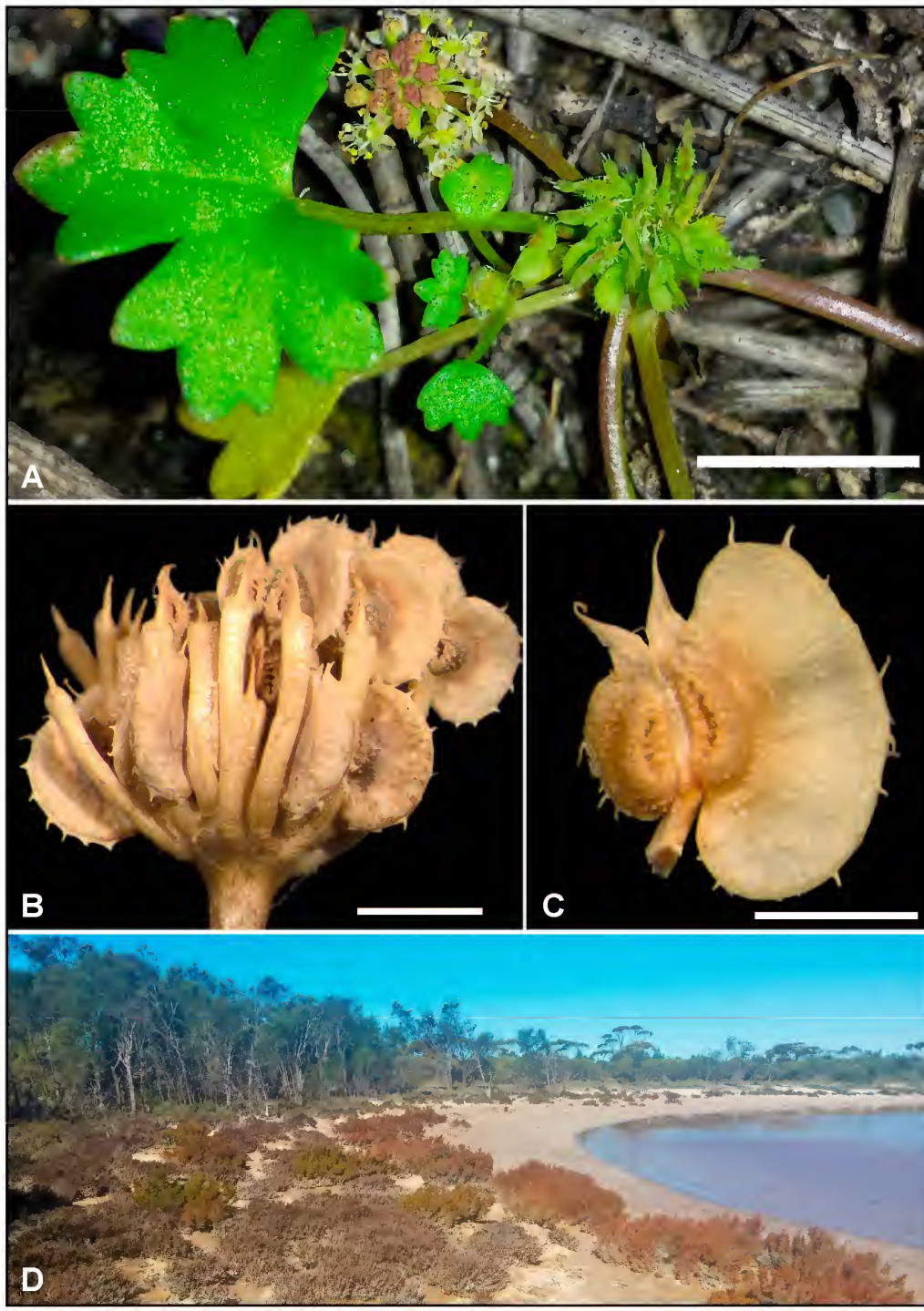

Figure 1. *Hydrocotyle spinulifera*. A – flowering plant *in situ* showing an umbel with spinose fruit; B – fruiting umbel showing pedicels with persistent acerose carpophores; C – lateral view of schizocarp showing dimorphic mericarps with small spinose dorsal ribs; D – typical habitat. Scale bars = 10 mm (A); 2 mm (B, C). Voucher: *A.J. Perkins* AJP-WA 138 (A); *A. Crawford* 469 (B, C). Photographs by A. Perkins.

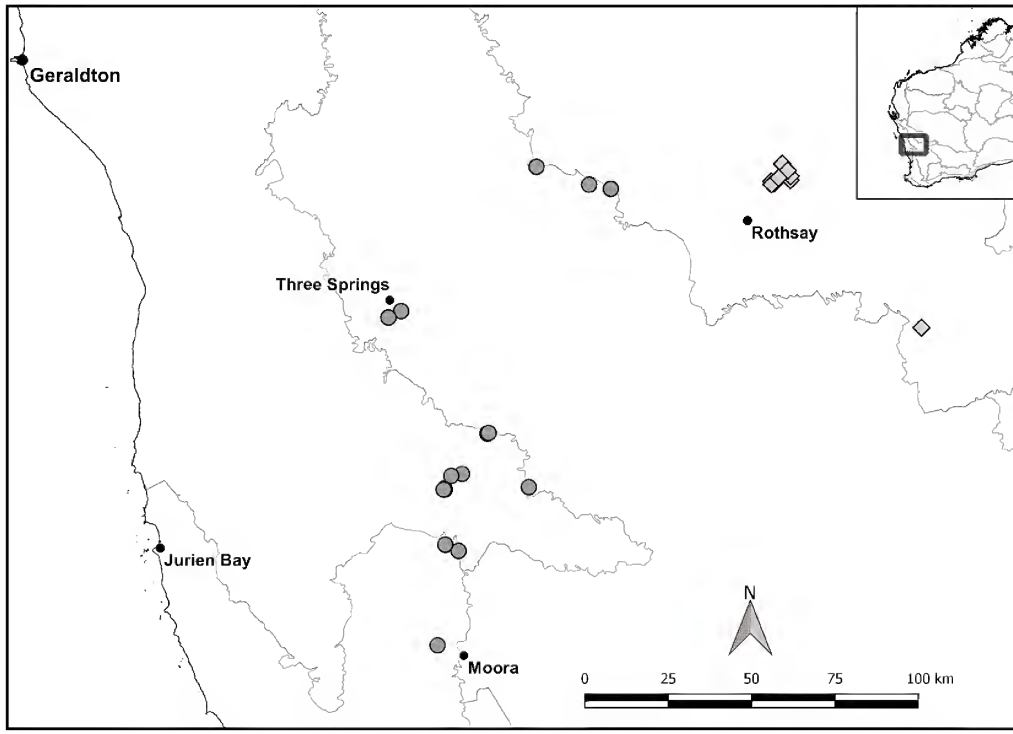

Figure 2. Distribution of *Hydrocotyle spinulifera* (●) and *H. dimorphocarpa* (◆) based on specimens held at PERTH and CANB. Map shows Interim Biogeographic Regionalisation for Australia version 7 bioregions (Department of the Environment 2013) in grey. Overview map for Western Australia shown in the top right corner.

Etymology. The epithet is derived from the Latin words *spinula*, 'a small spine', and *fero*, 'to bear', in reference to the small spines borne along the dorsal ribs of the mericarps (Figure 1A–C). The common name of 'Spiny Fruited Pennywort' is here suggested.

Affinities. *Hydrocotyle spinulifera* is morphologically similar to the rare Western Australian annuals *H. muriculata* (Figure 3C) and *H. dimorphocarpa* A.J.Perkins. All three species possess a subsessile umbel borne (centrally) amongst the leaves of the basal rosette as the first umbel to flower and fruit, schizocarps with at least one winged mericarp, and persistent carpophores.

Hydrocotyle spinulifera differs from *H. muriculata* by having glabrous stems and peduncles (hairy stems and peduncles in *H. muriculata*; Figure 3A), leaf lamina margins glabrous (small, acute hairs scattered along lamina margins, often on marginal teeth in *H. muriculata*), bases of fruiting pedicels connate (free in *H. muriculata*), mericarps dimorphic (both mericarps winged in *H. muriculata*; Figure 3B), mericarps with spinose dorsal ribs (glabrous dorsal ribs in *H. muriculata*), sepals setose (calyx absent in *H. muriculata*), and fruiting styles (see Figure 1C) distinctly swollen at base (see Figure 3B for styles of *H. muriculata*).

Additionally, *H. spinulifera* and *H. dimorphocarpa* both possess fruit with dimorphic mericarps, setose sepals, and connate pedicels (joined at the base by a membranous flap of tissue). *Hydrocotyle spinulifera* differs by having linear pedicles (flattened pedicels distinctly broader at their base than apex in *H. dimorphocarpa*), mericarps with spinose dorsal ribs (glabrous in *H. dimorphocarpa*), and

simple hairs on pedicel bases of the outermost whorl (multifid hairs with 2–12 wiry hair tips branching from a broad base in *H. dimorphocarpa*).

Hydrocotyle dimorphocarpa A.J.Perkins, *sp. nov.*

Type: north-north-east of Rothsay, Western Australia [precise locality withheld for conservation reasons], 24 September 2011, *R. Meissner & R. Coppen* 4723 (*holo*: PERTH 08433771; *iso*: CANB, NSW).

Hydrocotyle sp. Warriedar (P.G. Wilson 12267), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 13 September 2017].

Annual herbs consisting of a basal rosette of leaves and branches bearing leaves and umbellate inflorescences, 1–5 cm high, 2.5–20 cm wide. *Stems* decumbent, terete, glabrous, pale green to reddish green. *Stipules* white, lanceolate to ovate, 2.5–4.5 mm long, 1.5–3.0 mm wide, membranous, translucent, irregularly fringed to ciliate along margins. *Petioles* crimson to reddish green, 9–40 mm long, glabrous or with scattered wiry hairs (along the upper half) becoming most dense towards the base of the leaf lamina. *Leaf blades* simple, dorsiventral, discolorous, carnose, broadly ovate and trilobed or shallowly palmatifid in juvenile leaves, trilobed to pedately lobed in mature leaves, 6–21 mm long, 6–30 mm wide; adaxial surface uniformly green or occasionally reddish green, glabrous; abaxial surface dark crimson to reddish green, glabrous (particularly in juvenile leaves) or occasionally with scattered, simple, antrorse hairs (in mature pedate leaves). *Leaf margins* toothed, teeth obtuse to acute, sometimes tipped with short acute hairs. *Median leaf lobes* ovate to obovate, 5–16 mm long, 3–11 mm wide, margins with 1–3 teeth. *Lateral leaf lobes* 5–16 mm long, 4–16 mm wide, 2–8 marginal teeth, incised into two asymmetrical lobules in pedate leaves; leaf sinuses 10–60% of lateral lobe length. *Inflorescences* leaf-opposed, simple umbels, anthesis centripetal, 18–36-flowered, 4–12 mm wide, the first umbel to flower and fruit borne centrally on a peduncle distinctly shorter than rosette leaves, with successive umbels borne along stems radiating out from the basal rosette. *Peduncles* terete, shorter than subtending leaves, 1–34 mm long, glabrous. *Involucral bracts* absent. *Pedicels* white to cream, distinctly dorsiventrally flattened, recurved in outermost flowers, erect in innermost flowers, 0.5–2.0 mm long, arranged in three whorls; outermost ones basally connate (joined to neighbouring pedicels by a membranous flap of tissue), with 1 appressed, multifid hair (2–12 wiry acropetal hair tips branching from a broad base). *Flowers* all hermaphrodite, protandrous. *Sepals* 5, filiform, setose, 0.7–0.8 mm long. *Petals* 5, predominantly cream with pale pink to crimson on the dorsal surface (towards the apex), ovate, 0.5–0.8 mm long, 0.3–0.5 mm wide. *Filaments* white, 0.7–0.9 mm long. *Anthers* light yellow, 0.2–0.3 mm long. *Ovaries* pale green at anthesis, bilaterally flattened, orbicular, glabrous along dorsal ribs. *Fruiting pedicels* incurved at maturity, 1.0–6.5 mm long, 0.5–1.5 mm wide at base (narrower at apex), outermost ones distinctly longer and wider than inner two whorls. *Schizocarps* bilaterally flattened, bearing dimorphic mericarps; *mericarps* light green turning light creamy brown on outer (flattened) margins and reddish brown (centrally) at maturity; commissure 70–80% the length of inner mericarps and 30–50% of the winged outer mericarp. *Outer mericarps* markedly winged (between the dorsal and lateral ribs), 1.6–2.7 mm long, 1.0–2.0 mm wide; wing cordate, glabrous; dorsal ribs prominent, glabrous along margins; lateral ribs prominently raised; outer surface of (raised) lateral ribs convex, papillate, minutely colliculate; surface between (raised) lateral ribs and median ribs deeply concave, papillate, minutely colliculate. *Inner mericarps* orbicular, 1.0–1.2 mm long, 0.7–1.0 mm wide, morphologically similar to outer mericarps except for the lack of a wing. *Carpophores* persistent, acerose, 0.4–0.6 mm long. *Fruiting styles* swollen at the base, 0.8–1.0 mm long, reflexed. *Cotyledons* narrowly elliptic to oblong in the seedlings. (Figure 4A–C)

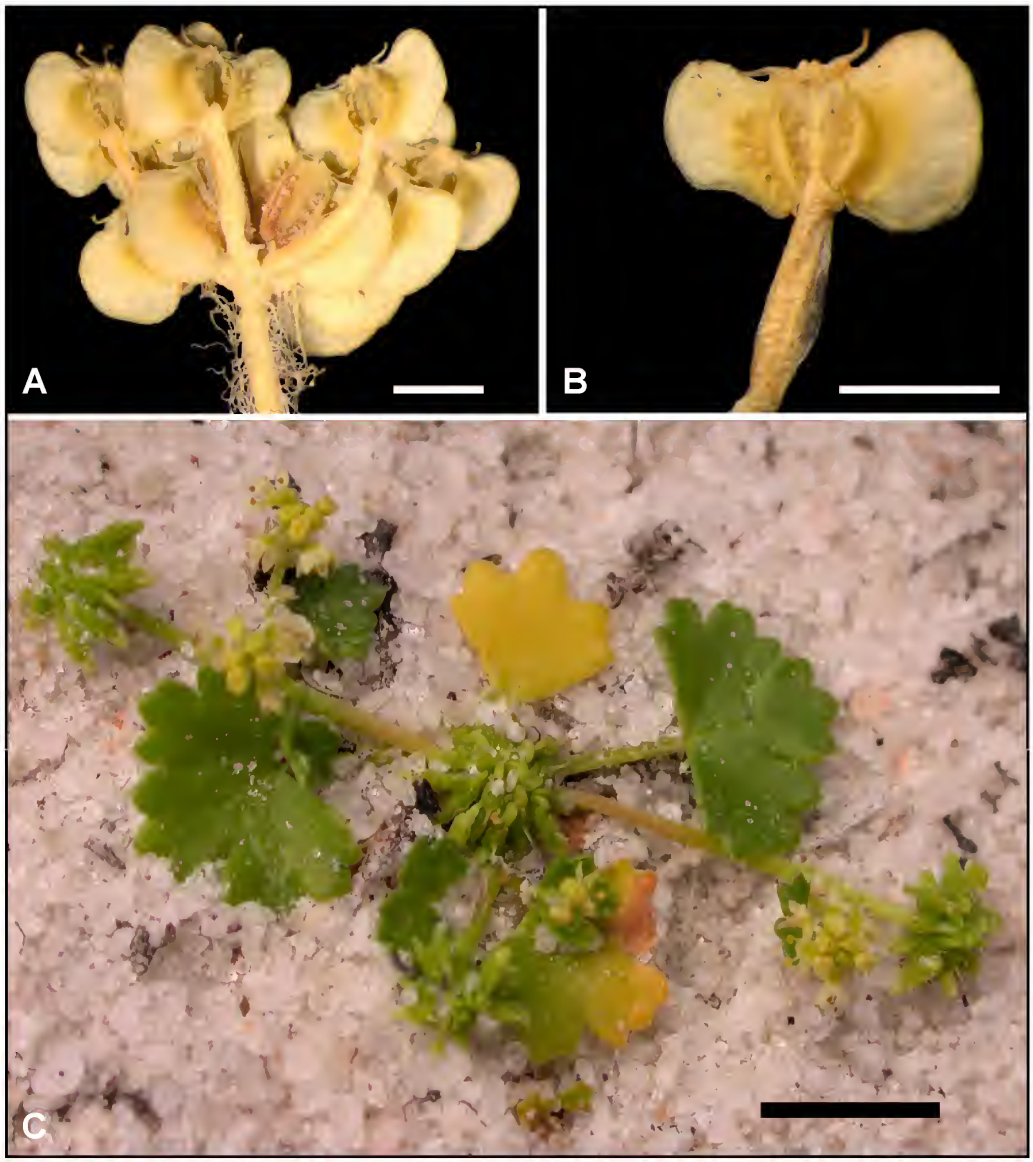

Figure 3. *Hydrocotyle muriculata*. A – fruiting umbel subtended by a hairy peduncle; B – schizocarp showing both mericarps with wings; C – flowering plant *in situ* showing the primary umbel (at the centre of the plant) with developing fruit. Scale bars = 2 mm (A, B); 10 mm (C). Voucher: *Hj. Eichler* 23103 (A, B); *A.J. Perkins s.n.* (PERTH 08012741) (C). Photographs by A. Perkins.

Diagnostic features. *Hydrocotyle dimorphocarpa* can be distinguished from all other taxa in *Hydrocotyle* by possessing the following combination of characters: annual herbs with the first umbel to flower and fruit borne centrally amongst the basal rosette on a peduncle (1–7 mm long) distinctly shorter than rosette leaves; fruiting pedicels distinctly dorsiventrally flattened with the base distinctly broader than the apex, arranged in three whorls, connate at their base with outermost whorl of pedicels additionally being joined to neighbouring pedicels by a membranous flap of tissue, at the base of each (outer whorl) pedicel is an appressed multifid hair (3–12 wiry acropetal hair tips branching from a broad base); sepals filiform, setose; ovaries and mature mericarps glabrous along dorsal ribs; mature schizocarps with outer mericarp distinctly winged and the other wingless; carpophores persistent, acerose.

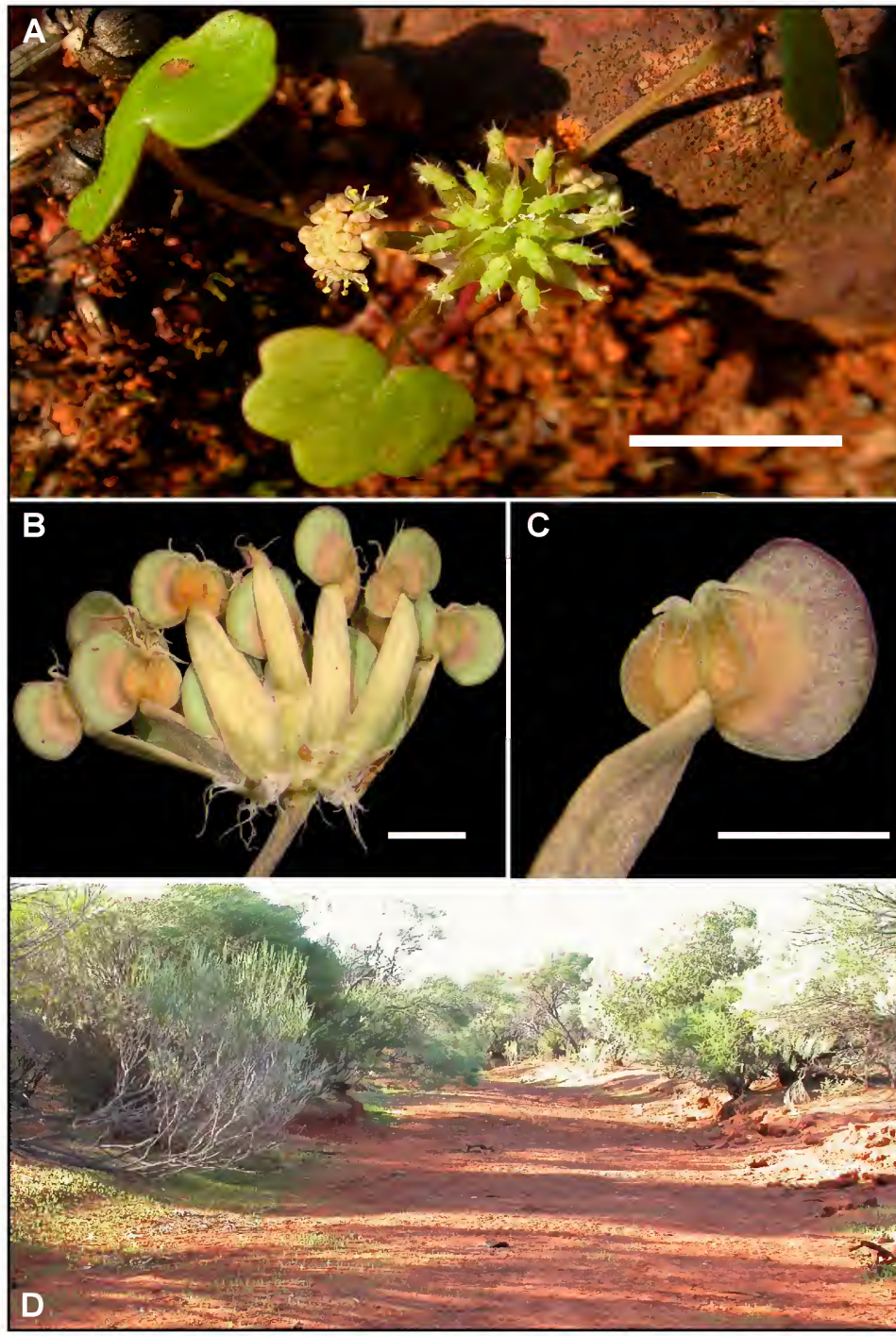

Figure 4. *Hydrocotyle dimorphocarpa*. A – plant *in situ* showing an umbel with developing fruit and setose sepals, and a subsequent umbel in flower; B – fruiting umbel showing flattened pedicels with multifid hairs at the base; C – schizocarp with dimorphic mericarps; D – typical habitat. Scale bars = 10 mm (A); 2 mm (B, C). Voucher: *A.J. Perkins s.n.* (PERTH 08048444) (A); *R. Meissner & R. Coppen* 4723 (B, C). Photographs by A. Perkins.

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 2 Sep. 2003, *D. Coultas s.n.* (PERTH 07343817); 27 Sep. 2004, *C. Godden & G. Woodman* Hsw Loc 1 (PERTH); 29 Sep. 2004, *C. Godden & G. Woodman* Hsw Loc 28 (PERTH); 24 Sep. 2011, *R. Meissner & R. Coppen* 4722 (PERTH); 25 Sep. 2011, *R. Meissner & R. Coppen* 4721 (PERTH); 26 Sep. 2011, *R. Meissner & R. Coppen* 4719 (PERTH); 26 Sep. 2011, *R. Meissner & R. Coppen* 4720 (PERTH); 28 Sep. 1998, *C.J. Nicholson* 37 (PERTH); 4 Oct. 2007, *A.J. Perkins s.n.* (NSW, PERTH 08048444, SYD); 26 Sep. 1986, *P.G. Wilson* 12267 (PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from September to October.

Distribution and habitat. *Hydrocotyle dimorphocarpa* is only known from two general localities within the Yalgoo bioregion (Figure 2), one near Mt Gibson and the other within ex Warriedar Station, north-east of Rothsay. Plants grow in open woodland and mallee along creekbanks or drainage lines containing red-brown clay loam soils (Figure 4D).

Conservation status. *Hydrocotyle dimorphocarpa* is listed by Smith and Jones (2018) as Priority One under Conservation Codes for Western Australian Flora, under the name *Hydrocotyle* sp. Warriedar (P.G. Wilson 12267). The two known areas of occurrence of this species are over 100 km apart.

Etymology. The epithet is derived from the Greek *dimorphos*, 'two-shaped', and *carpos*, 'fruit', in reference to the mature schizocarps having dimorphic mericarps (Figure 4B, C), with one mericarp being winged and the other lacking a wing. The common name of 'Single-winged Pennywort' is here suggested.

Affinities. *Hydrocotyle dimorphocarpa* is morphologically similar to the rare Western Australian annuals *H. muriculata* and *H. spinulifera*. All three species possess a shortly pedunculate umbel borne centrally amongst the leaves of the basal rosette as the first umbel to flower and fruit, schizocarps with at least one winged mericarp and persistent carpophores. *Hydrocotyle dimorphocarpa* differs from both *H. muriculata* and *H. spinulifera* by having fruiting pedicels distinctly dorsiventrally flattened with the base distinctly broader than the apex (pedicels linear in *H. muriculata* and *H. spinulifera*), and outermost pedicels with an appressed multifid hair consisting of 3–12 acropetal hair tips branching from a broad base (simple or rarely bifid hairs on pedicels in *H. spinulifera* and glabrous pedicels *H. muriculata*).

Hydrocotyle dimorphocarpa is closely allied to *H. spinulifera* (thus differing from *H. muriculata*) as both taxa possess fruit with dimorphic mericarps, setose sepals, connate pedicels (joined at the base by a membranous flap of tissue) and glabrous peduncles. *Hydrocotyle dimorphocarpa* can be further distinguished from *H. spinulifera* by the fruit being glabrous along the dorsal ribs (spinose along the dorsal ribs in *H. spinulifera*) (Figures 1, 4).

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References

Department of the Environment (2013). *Australia's bioregions (IBRA)*, IBRA7, Commonwealth of Australia. http://www.environment.gov.au/land/nrs/science/ibra#ibra [accessed 13 September 2017].

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 1 February 2018].

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SHORT COMMUNICATION

Commersonia corniculata (Malvaceae), a new name for *C. cygnorum*

The application of the name *Lasiopetalum corniculatum* Sm. (Malvaceae) has hitherto been uncertain (CHAH 2012). Upon describing this species, Smith (1812) provided the common name 'Horned Woolly-blossom' in reference to the petals having 'linear points as long as the calyx'; however, species of *Lasiopetalum* Sm. have only small, scale-like petals, or lack petals altogether. He based his description on material collected by Archibald Menzies from 'King George's Sound', a specimen of which is held in the Smith Herbarium at the Linnean Society of London. Examination of an image of this specimen (LINN-HS 403.5: http://linnean-online.org/31802/) has revealed that it is referable to the later-named *Commersonia cygnorum* Endl. (Steudel 1845).

Our interpretation of the type is largely based on our observation that its flowers have narrowly-ovate calyx lobes with an acute apex, and petals with linear ligules that equal or exceed the apex of the calyx (see description in Wilkins & Whitlock 2011). *Commersonia borealis* (E.Pritz.) C.F.Wilkins & Whitlock, the closest relative of *C. cygnorum*, also has long ligules but differs in part by having glabrous staminodes or with occasional hairs (*cf.* densely stellate hairy on the outer surface). While this feature is difficult to confirm from the image, our interpretation is supported by distributional data: *C. cygnorum* occurs in the Perth region and along the south-west coast of Western Australia, from east of Augusta to Cape Le Grand (including King George Sound), whereas *C. borealis* is found to the north of Perth, from Seabird to Shark Bay. Since *L.* corniculatum is the earliest legitimate name for this species, the following new combination is necessary.

Commersonia corniculata (Sm.) K.A.Sheph. & C.F.Wilkins, *comb. nov.*

Lasiopetalum corniculatum Sm. in A. Rees, *Cycl.* 20 (1812). *Type citation*: 'Gathered by Mr Menzies, at King George's Sound.' *Type specimen* 'King George's Sound, west coast of New Holland [Western Australia]; lat. 35. Mr. Menzies. 1803 [1791]' (*lecto*, here designated (or possible *holo*): LINN-HS 403.5 image!).

Commersonia cygnorum Steud. in J.G.C. Lehmann, *Pl. Preiss.* 1(2): 237 (1845); *Restiaria cygnorum* (Steud.) Kuntze, *Revis. Gen. Pl.* 1: 81 (1891); *Rulingia cygnorum* (Steud.) C.A.Gardner, *Enum. Pl. Austral. Occ.*: 80 (1931). *Type citation*: 'Ad caput fluvii Cygnorum. Herb. Preiss. No. 1642.' (*lecto*, *fide* C.F. Wilkins & B.A. Whitlock, *Austral. Syst. Bot.* 24: 250 (2011), or possible *holo*: LD 1241713 image!).

Rulingia malvifolia Steetz in J.G.C. Lehmann, *Pl. Preiss*. 2: 356 (1848), *nom. illeg.*, *nom. superfl. Type citation*: 'Hab. in Novae Hollandiae ora australi-occidentali, in Swan-River Colonia, Drummond! Collect. 1. No. 374!; Collect. 2. No. 72!'; Ad ostium fluminis Swan-River, mense Januar. 1840. Preiss! (Herb. Preiss. No. 1642!) v.s.' *Type specimens*: *J. Drummond* 2: 72 (*lecto*, *fide* C.F. Wilkins & B.A. Whitlock, *Austral. Syst. Bot.* 24: 250–251 (2011): W!; *isolecto*: BM 000522457!, G 00358538 image!, G 00358539 image!, K 000671940!, K 000671941!, NSW 632636 *n.v.*, MEL 2212706!, P 04022194 image!, P 04022195 image!, W!); *J. Drummond* 1: 374 (*paralecto* [*syn*]: W!); *L. Preiss* 1642 (*paralecto* [*syn*]: LD 1241713 image!).

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Notes. The designated lectotype, which is the only specimen from Menzies' gathering that we are currently aware of, is annotated by Smith as 'Bütnerioides No. 2. Lasiopetalum corniculatum Rulingea?'. Menzies visited King George Sound in 1791 during Vancouver's *Discovery* expedition (George 2009): the date given on the specimen is likely to refer to the date the specimen was received by Smith.

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Thanks to John Huisman and Juliet Wege for providing helpful comments on an earlier draft of this communication. The curation staff at PERTH are also gratefully acknowledged for their patience in dealing with the seemingly endless curatorial tasks that result from our ongoing research.

References

CHAH (Council of Heads of Australasian Herbaria) (2012). *Australian Plant Census*. https://id.biodiversity.org.au/instance/apni/774273 [accessed 29 January 2018].

George, A.S. (2009). *Australian botanist's companion.* p. 481–482. (Four Gables Press: Kardinya, Western Australia.)

Smith, J.E. (1812). *Lasiopetalum. In*: Rees, A. (ed.) *The Cyclopaedia or universal dictionary of arts, science and literature.* Vol. 20. (Longman, Hurst, Rees, Orme & Brown etc.: London.)

Steudel, E.G. von (1845). *Commersonia. In*: Lehmann, J.G.C. (ed.) *Plantae Preissianae sive enumeratio plantarum quas in Australasia occidentali et meridionali-occidentali annis 1838–1841 collegit Ludovicus Preiss*. p. 237. (Sumptibus Meissneri: Hamburg.)

Wilkins, C.F. & Whitlock, B.A. (2011). A revision of *Commersonia* including *Rulingia* (Malvaceae *s.l.* or Byttneriaceae). *Australian Systematic Botany* 24: 226–283.

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SHORT COMMUNICATION

Tephrosia pedleyi (Fabaceae: Millettiae), a new species from the west Kimberley of Western Australia

A new, orange-flowered species of *Tephrosia* Pers. from Western Australia is described herein. This species was recognised as putatively new by Les Pedley in 1984 (*in sched.*), and the concept embodied by his annotated specimens led to it being recognised as '*Tephrosia* sp. C' by Wheeler (1992) prior to being included on the Western Australian vascular plant census as *T.* sp. C Kimberley Flora (K.F. Kenneally 5599); it is named in his honour.

Tephrosia pedleyi R.Butcher, *sp. nov.*

Typus: [near] Frome Rocks, Dampier District, Western Australia [precise locality withheld for conservation reasons], 8 June 1999, *J. Grimes, D. Murphy & C. Hohnen* JG 3557 A (*holo*: MEL 2074296, image!; *iso*: PERTH 05978793!).

Tephrosia sp. C, J.R. Wheeler, *Fl. Kimb. Reg.* p. 452 (1992).

Tephrosia sp. C Kimberley Flora (K.F. Kenneally 5599), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 20 November 2017].

Spindly to rounded, erect *subshrub*, 0.3–0.8 m tall, 0.1–1 m wide; multistemmed at or near base, mature stems corky; taproot unspecialised. *Branchlets*, *leaf and inflorescence rachides* with moderately dense to dense, short, straight, appressed, usually stramineous indumentum, 0.15–0.45 mm long. *Leaves* pinnate, up to 175 mm long including petiole; *stipules* persistent, antrorse at first then inclined 45–80º, attenuate to lanceolate, 1.6–4.7 mm long; *petiole* 13–46 mm long; *ultrajugal rachis* usually absent, very rarely to 6 mm long; *stipellae* absent; *petiolules* 0.4–0.8 mm long; *leaflets* (7–)13–19, linear, strongly channelled in T.S., at least some attached in basal half of leaf, base attenuate, apex acute to rounded, deflexed, not to scarcely mucronate, mucro 0.1–0.2 mm long; lateral leaflets 7.1–60 mm long, 0.6–1.3 mm wide, length 8.9–46.2 × width; terminal leaflet 1–1.95 × length of adjacent laterals, 7.2–58 mm long, 0.7–1.8 mm wide, length 6–36.3 × width; lamina concolorous; upper surface sparsely to moderately hairy, the hairs appressed, straight, stramineous, occasionally also white; lower surface glabrescent (hairs as above where seen), smooth; secondary and intersecondary veins obscured due to narrowness of leaf. *Inflorescence* pseudoracemose, leaf-opposed, 110–425 mm long, with 3–12(–15) flowers in each cluster (often forming short lateral shoots in axils of inflorescence bracts); *floral bracts* 0.6–0.9 mm long, deltoid, acute, caducous; *bracteoles* absent; *pedicel* 1.8–5.3 mm long. *Calyx* 2.7–3.9 mm long; indumentum moderately dense to dense, the hairs straight, appressed, stramineous; tube 1.7–2.4 mm long, 1.3–1.9 × the length of lateral lobes; lower and lateral lobes broadly ovate with acute apices; vexillary lobes united a little higher than lower three, free for 0.2–0.5(–0.7) mm (divided to 19–50(–63)% length); lowest lobe 1–1.7 mm long, ±equal to lateral lobes. *Corolla* orange; *standard* 5–6.2 mm long, 5.9–7.8 mm wide, the claw 1.4–2 mm long with thickened margins, the blade transversely reniform to suborbicular, slightly callused at base, apex emarginate; *wings* 5–6.7 mm long, 2.4–3.4 mm wide, a little longer than keel, the blade obovate to broadly obovate, the apex rounded;

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keel 4.5–5.7 mm long, 2.2–3 mm wide, the blade semi-circular, broadly pouched in front of spur, mostly glabrous or with a few hairs along the lower margin towards apex. *Staminal* tube glabrous near fenestrae, which are slightly callused on margins; vexillary filament glabrous, slightly callused near base; anthers 0.50–0.65 mm long, 0.35–0.55 mm wide. *Ovary* densely hairy; ovules 4–6, positioned proximally in the ovary with a distal void (void not evident in mature fruits). *Style* flattened, almost uniform along length, mostly glabrous; stigma with hairs at base, linear. *Pods* linear, straight or slightly upturned at apex, 36–42 × 3.5–4 mm, laterally compressed, depressed between seeds, tan at maturity; indumentum moderately dense, appressed, white and stramineous; beak in line with upper suture, deflexed; tissue between seeds membranous. *Seeds* 4–6 per pod, with 5.5–6.5 mm between centres of adjacent seeds, compressed-transversely ellipsoid, 2–2.5 × 3–3.5 mm, orange-brown, testa smooth, hilum ±central to excentric; caruncle absent. (Figure 1)

Diagnostic features. *Tephrosia pedleyi* is readily distinguished by the following combination of characters: erect subshrub to *c.* 0.8 m tall, with an indumentum of short, appressed, usually stramineous hairs; stipules persistent, 1.6–4.7 mm long; leaves with (3–)6–9 pairs of lateral leaflets, usually lacking an ultrajugal rachis, leaflets linear, canaliculate 7.1–60 mm long; calyx 2.7–3.9 mm long, with the tube 1.3–1.9 × lateral lobe length; flowers orange, in elongate pseudoracemes, with glabrous stamens and 4–6 ovules positioned proximally in the carpel; pods straight to slightly upturned at apex, 36–42 × 3.5–4 mm, with moderately dense indumentum of appressed, white and stramineous hairs, and the beak in line with the upper suture and deflexed.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 20 Aug. 2001, *C.P. Campbell* 3421 (DNA, PERTH); 17 Sep. 2011, *P. Docherty* 275 (BRO., PERTH); 12 Aug. 1976, *K.F. Kenneally* 5599 (CANB, PERTH); 15 Aug. 1976, *K.F. Kenneally* 5679 (PERTH); 15 Sep. 1959, *M. Lazarides* 6540 (BRI, CANB, DNA, NSW, PERTH); 20 June 2017, *A. Markey & R. Coppen* LG 10005 (MEL, PERTH); 20 July 2017, *A. Markey & R. Coppen* LG 10006 (BRI, DNA, PERTH); 20 July 2017, *A. Markey & R. Coppen* LG 10007 (BRI, CNS, PERTH); 16 Aug. 2017, *A. Markey & R. Coppen* LG 10008 (DNA, PERTH).

Phenology. Flowers and fruits collected June to September, with timing apparently dependent on local conditions. One specimen from June (the type) has flowers and mature pods with seeds, and one specimen from September (*M. Lazarides* 6540) is close to sterile; the remainder, collected from June to September, have flowers and developing or immature pods.

Distribution and habitat. On current knowledge, occurs primarily in the Dampierland bioregion of Western Australia, with limited extension southward into adjacent areas of the Great Sandy Desert (Figure 2). Grows in red sand, loamy sand or sandy laterite, on gently undulating sandplain or among dunes. In pindan country *T. pedleyi* has been collected from sites with scattered trees to open woodland (*Bauhinia cunninghamii*, *Corymbia greeniana*, *C. zygophylla*, *Dolichandrone occidentalis*, *Gyrocarpus americanus*) over sparse to very sparse tall shrubland (*Acacia eriopoda*, *A. monticola*, *Grevillea refracta*, *Persoonia falcata*), sparse low shrubs (*Corchorus sidoides*, *Cullen corallum*, *Dodonaea hispidula*, *Halgania solanacea*, *Newcastelia cladotricha*, *Seringia katatona*) and mid-dense to dense grassland (*Aristida holathera*, *A. inaequiglumis*, *Chrysopogon pallidus*, *Eriachne ciliata*, *Sorghum plumosum*, *Triodia* spp.), with a sparse herb layer (*Bulbostylis barbata*, *Goodenia sepalosa*, *Heliotropium leptaleum*, *Polycarpaea corymbosa*, *Scaevola parvifolia*, *Trianthema pilosum*). In dune country, recorded as occurring in open, low vegetation comprising *Acacia* spp., *Eucalyptus* spp., *Grevillea eriostachya*, *Hibiscus* sp., *Newcastelia* sp., and *Triodia* spp.

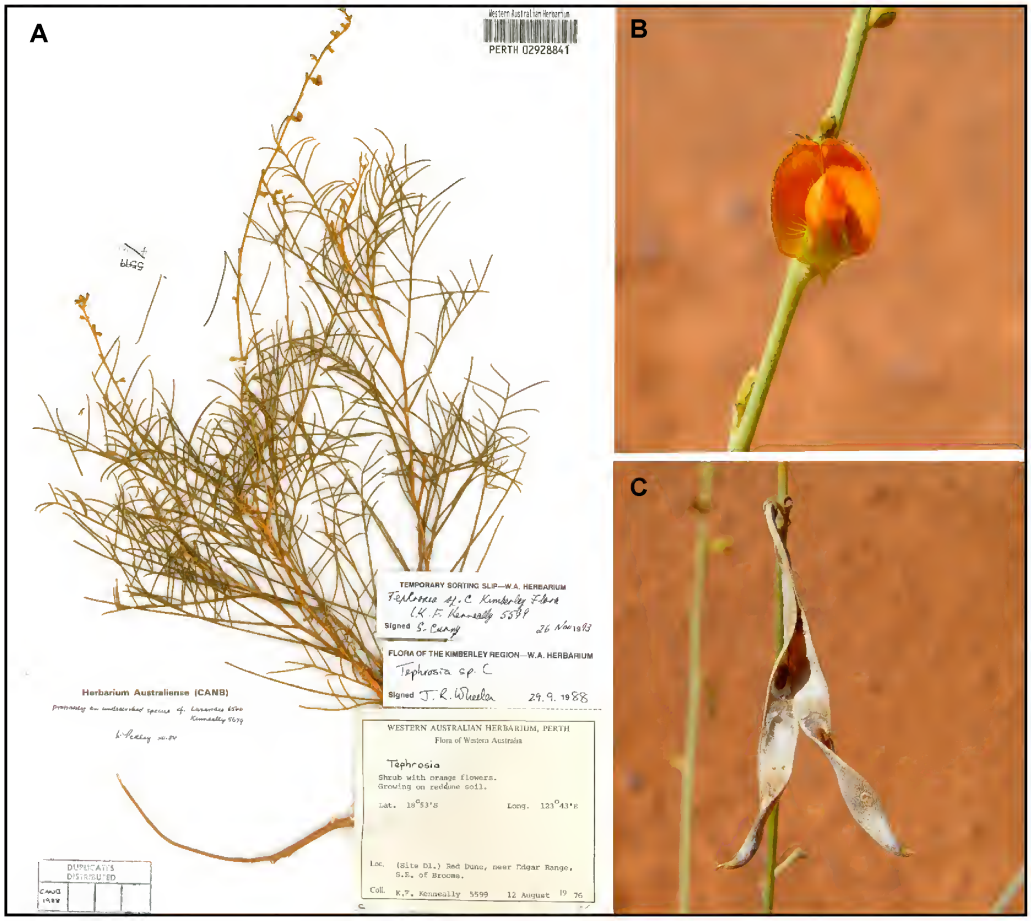

Figure 1. *Tephrosia pedleyi*. A – herbarium specimen showing leaf morphology, elongate pseudoracemes, and stramineous indumentum; B – flower from front; also buds with appressed, stramineous indumentum on the outer surface of the calyx; C – dehisced pod, showing membranous tissue between seeds. Photographs by G. Byrne from unlodged specimen *G. Byrne* 1464 (B, C); used with permission.

Conservation status. This species is listed as Priority One under Conservation Codes for Western Australia, under the name *T.* sp. C Kimberley Flora (K.F. Kenneally 5599) (Smith & Jones 2018).

Etymology. Named for Les (Leslie) Pedley (1930–), a taxonomic expert on the genus *Tephrosia*, who is currently focussed on revising the Queensland taxa (see Pedley 2014), and who first recognised this species as new.

Affinities. *Tephrosia pedleyi* is clearly distinct from all other Western Australian *Tephrosia* taxa, but very similar to the Queensland taxon *T.* sp. Mt Isa (P.L. Harris 277) *s. str.*[1]. While these two orange-flowered taxa are extremely similar in their inflorescence and vegetative features, and in the indumentum

[1]Herein meaning the voucher specimen *P.L. Harris* 277 and collections approximating this (i.e. BRI: *Farrell* 316, *Bradford* 15, *Wilson* 644 *& Rowe*, *Specht* 45 *& Rogers*, *Fell* 4907, *Booth* 3586, *Schmid* 405 & 611, *Forster* 22172 & 22317 *& Booth*). There is considerable variation among the specimens identified as *T.* sp. Mt Isa (P.L. Harris 277) at BRI, including both orange- and pink-/purple-flowered collections, and it appears that there are at least two taxa filed under that phrase name at present.

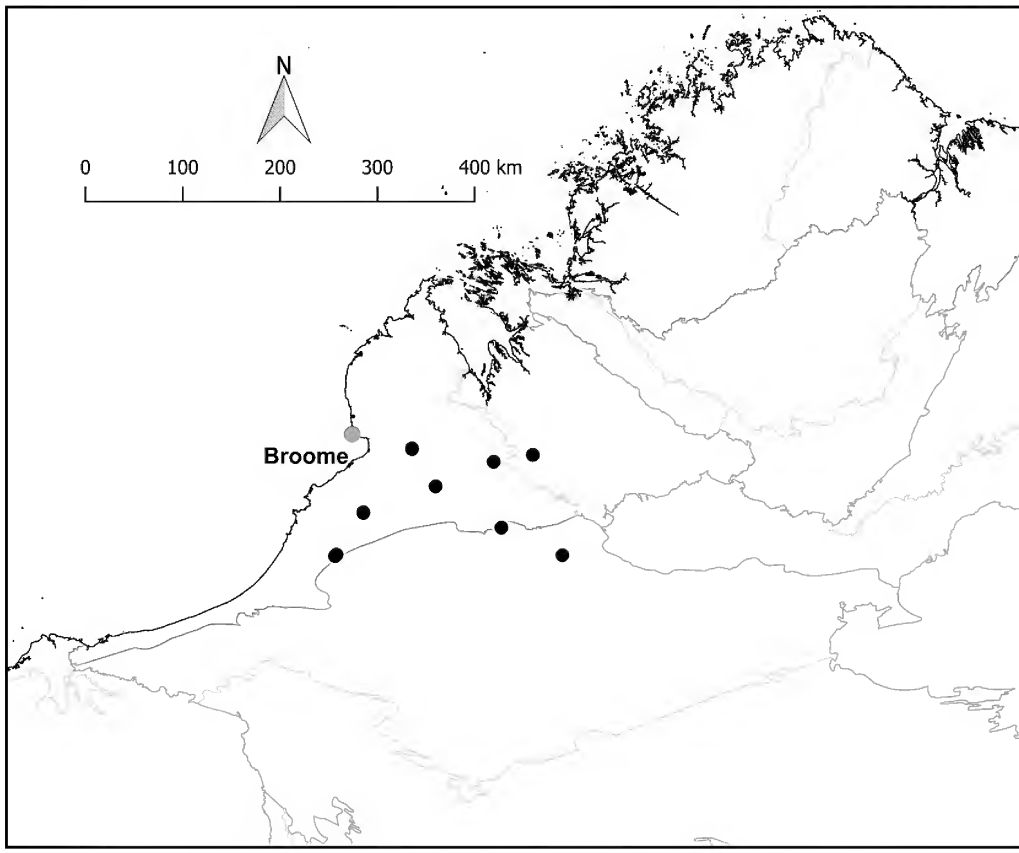

Figure 2. Distribution of *Tephrosia pedleyi* in northern Western Australia, where it is known from the Dampierland bioregion and adjacent parts of the Great Sandy Desert bioregion. IBRA v 7 bioregions shown in dark grey with subregions shown in light grey (Department of the Environment 2013).

and dimensions of their calyces, they have a number of differences, which, given their geographic disjunction, has led to them being retained as distinct (Butcher *et al.* 2017). In particular, *T.* sp. Mt Isa has deltoid calyx lobes with the lowermost one noticeably longer than the lateral pair, an entire apex to its standard petal[2], patent hairs on the vexillary staminal filament (in front of the prominent callosities and extending towards the anther over a long distance), hairs near the fenestrae and often on the sides of the staminal tube, 9–11 ovules, and patent hairs on the longer (44.5–63 mm long) pods, which have a distinctly upturned apex. It also tends to have an ultrajugal rachis (1.5–17 mm long) below the terminal leaflet, although this character has been found to be variable within other taxa. These two taxa also differ in their habitat, with *T.* sp. Mt Isa growing in open woodland (predominantly *Eucalyptus leucophloia*) in rocky soils (quartzite and laterised sandstone) associated with outcrops and hills.

Among the Western Australian *Tephrosia* taxa, *T. pedleyi* is most similar to *T.* sp. sparse pinnae (C.R. Michel 2202), a *T. subpectinata* Domin ally from the central and northern Kimberley and the Northern Territory, with which it shares orange flowers, linear leaflets and leaves that typically lack an ultrajugal rachis. *Tephrosia* sp. sparse pinnae can be readily distinguished, however, by the

[2]The voucher specimen *P.L. Harris* 277 also has distinct, elongate auricles at the base of the standard petal blade, which are not shared with any of the other *T.* sp. Mt Isa specimens cited above for which flowers were available for study.

following characters: glabrous to sub-glabrous vegetative parts; calyces glabrous or with sparse, white indumentum; ovary with 6–8 ovules; large ((37–)45–52 mm long), sub-glabrous to sparsely hairy pods with a gently upturned to upturned apex and a short, straight beak; seeds with a white to cream, annular caruncle around the hilum.

Tephrosia pedleyi is superficially similar to narrow-leafleted specimens of *T.* sp. B Kimberley Flora (C.A. Gardner 7300) from the Pilbara and Gascoyne bioregions, but this can be distinguished by the following: leaves with an ultrajugal rachis (1–9 mm long) and caducous stipules; larger flowers (corolla 8.5–9.5 mm long) with notably hairy and callused staminal filaments; differently-shaped calyx, with the upper lobes strongly fused, the tube strongly arched below the upper lip, and the lower lobe longer than the laterals; ovary with 8–10 ovules; pods achieving a much greater length (30–70 × 3–5 mm), with an excentric beak; seeds transversely obloid to pulvinate, and mottled mid- and dark brown, brown and tan, or olivaceous, brown and tan.

Acknowledgements

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References

Butcher, R., van Leeuwen, S. & Thiele, K. (2017). Taxonomic studies in *Tephrosia* Pers. (Fabaceae) in northern Western Australia. Final report for Rio Tinto Pty Ltd – MesaA Terrestrial Offset Project, 8th May 2017. (Western Australian Herbarium, Department of Parks and Wildlife: Kensington, Western Australia).

Department of the Environment (2013). *Australia's bioregions (IBRA)*. IBRA7, Commonwealth of Australia. http://www.environment.gov.au/land/nrs/science/ibra#ibra [accessed 14 February 2018].

Pedley, L. (2014). Systematics of *Tephrosia* Pers. (Fabaceae: Millettieae) in Queensland: 1. A summary of the classification of the genus, with the recognition of two new species allied to *T. varians* (F.M.Bailey) C.T.White. *Austrobaileya* 9(2): 229–243.

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 13 February 2018].

Wheeler, J.R. (1992). *Tephrosia*. *In*: Wheeler, J.R. (ed.), Rye, B.L., Koch, B.L. & Wilson, A.J.G. *Flora of the Kimberley region*. pp. 440–455. (Department of Conservation and Land Management: Perth.)

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An update to the taxonomy of some Western Australian genera of Myrtaceae tribe Chamelaucieae: 5. *Hysterobaeckea*

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Abstract

Rye, B.L. An update to the taxonomy of some Western Australian genera of Myrtaceae tribe Chamelaucieae: 5. *Hysterobaeckea*. *Nuytsia* 29: 75–107 (2018). Eight new species belonging to *Hysterobaeckea* (Nied.) Rye are described: *H. cornuta* Rye, *H. glandulosa* Rye, *H. graniticola* Rye, *H. longipes* Rye, *H. occlusa* Rye, *H. petraea* Rye, *H. pterocera* Rye and *H. setifera* Rye. *Hysterobaeckea ochropetala* (F.Muell.) Rye is broadly delimited and two new subspecies are described as subsp. *cometes* Rye and subsp. *reliqua* Rye. The new subspecies *H. setifera* subsp. *meridionalis* Rye is also described. Six of the new taxa have conservation priority. A key is given for the named members of the genus.

Introduction

Hysterobaeckea (Nied.) Rye has only recently been established as a genus (Rye 2015a) rather than a subgenus (Niedenzu 1893). It belongs to the tribe Chamelaucieae DC. of Myrtaceae and occurs in southern mainland Australia. Recombinations were made in Rye (2015a) for three named species of *Hysterobaeckea* but most of the Western Australian taxa remained undescribed. Eleven new Western Australian members of the genus are described here, using the same methodology as in previous papers of this series (see Rye 2013b).

A shared character for the three previously named species of *Hysterobaeckea* and a majority of the new taxa is the presence of a line-like groove on the adaxial surface of their leaves. These taxa are referred to here as the core group since they include the type species *H. behrii* (Schltdl.) Rye. Several species that lack this leaf character, but are otherwise similar in morphology to the core group, have also previously been considered to be closely related to *H. behrii*. One such species, which is associated with granite in the Northern Territory, was included by Bean (1997) in his concept of *H. behrii* [as *Babingtonia behrii* (Schltdl.) A.R.Bean]. This new species has recently been given the phrase name *H.* sp. Mt Zeil (D.E. Albrecht 8650) and is apparently closely related to two south-western Australian taxa from granite and lateritic outcrops that have also been placed in *H. behrii s. lat.* Molecular evidence (see below) indicates that the core group is closely related to one of the south-western species on rock outcrops, and also to a western arid-zone species from ironstone outcrops, *Baeckea* sp. Melita Station (H. Pringle 2738). The three Western Australian taxa from rocky outcrops are therefore included here as part of the genus *Hysterobaeckea*; they are described as *H. graniticola* Rye, *H. petraea Rye* and *H. occlusa* Rye.

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The generic limits of *Hysterobaeckea* need to be examined further using a combination of morphological and molecular evidence. This could result in additional species being included in the genus.

Published and manuscript names (1876–1996)

Prior to the 1990s, Western Australian species now placed in *Hysterobaeckea* were mostly included under the south-eastern Australian species *Baeckea behrii*. The only other validly published name in use was *B. ochropetala* F.Muell. (Mueller 1876), now known as *H. ochropetala* (F.Muell.) Rye.

Two invalidly published names for Western Australian species are listed in Table 1. One of these, *B. behrii* var. *brevifolia* F.Muell. *nom. nud.* (Mueller 1877), was replaced by the manuscript name *B. benthamii* Trudgen in 1994. A second western species was called *B. recurva* Trudgen ms in 1996. Both of the manuscript species names were included in the descriptive catalogue of Western Australian plant species by Paczkowska and Chapman (2000), but were replaced by phrase names in 2010.

Phrase names (1994–2015)

Numerous phrase names were applied to the *Hysterobaeckea* species under study here between 1994 and 2015 (see Table 1). Malcolm Trudgen established most of these, but *Baeckea* sp. Fitzgerald Peaks (P.J. Poli 53) and *B.* sp. Lake Brown (E. Merrall s.n. 1889) were established as part of the current study, as was the phrase name for the new species from the Northern Territory, *H.* sp. Mt Zeil (D.E. Albrecht 8650).

Molecular evidence

Lam *et al.* (2002) sampled *H. petraea*, a south-western Australian species of *Hysterobaeckea* from rock outcrops [as *H. behrii* W] and a Victorian sample of the type species [as *H. behrii* E]. These two taxa formed a strongly supported clade, but with 'considerable genetic distance between them' (Lam *et al.* (2002: 542), indicating that it is highly unlikely that they belong to the same species.

Later sampling placed *H. petraea* sister to a clade comprising *H. occlusa*, *H. ochropetala s. lat.*, the South Australian species *H. tuberculata* (Trudgen) Rye and *H. behrii* (Peter Wilson pers. comm.). *Hysterobaeckea occlusa* differs from other members of the genus in having an indehiscent fruit. Indehiscent fruits have arisen many times in the tribe Chamelaucieae, for example within the genera *Astartea* DC. (Rye 2013a) and *Babingtonia* Lindl. (Rye 2015b), so this character does not appear to be of any concern regarding the decision made here to include *H. occlusa* in *Hysterobaeckea*.

Current outcomes and future studies

All but one of the 26 Western Australian phrase names are placed under one of the 12 species or subspecies recognised here (see Table 1). The residual phrase name is transferred to the genus *Hysterobaeckea* to become *H.* sp. Exclamation Lake (M.E. Trudgen 1524). This taxon is known from two collections, which were made close together and may be from the same population; these have fruits but very few flowers attached. *Hysterobaeckea* sp. Exclamation Lake belongs to the *H. ochropetala* species complex, and does not appear to be particularly distinctive in its morphology although it is geographically distinct. It tends to have longer, narrower leaves than the rest of the complex, with a point up to 0.2 mm long, and probably occurs in a damper habitat, suggesting that it might warrant description as a subspecies. As it is very poorly known, a decision as to its status is deferred.

Table 1. Manuscript names, phrase names and invalidly published names for *Hysterobaeckea* species, with the year established.

Current name	Synonyms
Hysterobaeckea cornuta Rye	*Baeckea* sp. Bungalbin Hill (B.J. Lepschi & L.A. Craven 4586); 2004 *Baeckea* sp. Die Hardy Range (E. Mattiske J91); 2004 *Baeckea* sp. Mt Jackson (G.J. Keighery 4362); 2004
Hysterobaeckea glandulosa Rye	*Baeckea* sp. Kalgarin Hill Road (A.M. Lyne, L. Craven & F. Zich AML 1018); 2004
Hysterobaeckea graniticola Rye	*Baeckea* sp. Fitzgerald Peaks (P.J. Poli 53); 2015
Hysterobaeckea longipes Rye	*Baeckea* sp. Wubin (M.E. Trudgen 5404); 1996
Hysterobaeckea occlusa Rye	*Baeckea* sp. Melita Station (H. Pringle 2738); 1994 *Baeckea* sp. Mt Clifford (B. Severne 74002); 2004 *Thryptomene* sp. Leinster (G. Cockerton 1534); 1996
Hysterobaeckea ochropetala subsp. *cometes* Rye	*Baeckea* sp. Comet Vale (A.S. George 8078); 2004
Hysterobaeckea ochropetala (F.Muell.) Rye subsp. *ochropetala*	*Baeckea grandiflora* var. *ochropetala* W.E.Blackall *nom. inval.;* 1954 *Baeckea* sp. Lake Brown (E. Merrall s.n. 1899); 2004
Hysterobaeckea ochropetala subsp. *reliqua* Rye	*Baeckea* sp. Boorabbin (J.H. Willis s.n. 4/10/1961); 2004 *Baeckea* sp. Bulla Bulling (D.J.E. Whibley 4648); 2004 *Baeckea* sp. Coolgardie (A. Strid 21320); 2004 *Baeckea* sp. Gnarlbine Rocks (G. Barrett GRH469); 2004 *Baeckea* sp. Mt Clara (R.J. Cranfield 11693); 2004 *Baeckea* sp. Queen Victoria Rock (K.R. Newbey 6103); 2004 *Baeckea* sp. Roundtop Hill (P. Armstrong 05/843); 2010 *Baeckea* sp. Ubini (R. Pullen 9610); 2004
Hysterobaeckea petraea Rye	*Baeckea recurva* Trudgen ms; 1996 *Baeckea* sp. Barbalin (B.L. Rye & M.E. Trudgen BLR 241022); 2010 *Baeckea* sp. Pigeon Rocks (D. Grace DJP 281); 2004
Hysterobaeckea pterocera Rye	*Baeckea* sp. Flying Fox Mine (A. O'Connor & V. Longman FF532); 2004
Hysterobaeckea setifera subsp. *meridionalis* Rye	*Baeckea behrii* var. *brevifolia* F.Muell. *nom. nud.;* 1877 *Baeckea benthamii* Trudgen ms; 1994 *Baeckea* sp. Bencubbin-Koorda (M.E. Trudgen 5421); 2004 *Baeckea* sp. Lake Campion (A. Coates AC 2285); 2010
Hysterobaeckea setifera Rye subsp. *setifera*	*Baeckea* sp. Wanarra (M.E. Trudgen 5376); 2010
Hysterobaeckea sp. Exclamation Lake (M.E. Trudgen 1524)	*Baeckea* sp. Exclamation Lake (M.E. Trudgen 1524); 2004

Generic description

Hysterobaeckea (Nied.) Rye, *Nuytsia* 25: 213 (2015). *Baeckea* subg. *Hysterobaeckea* Nied., *Nat. Pflanzenf.* 3(7): 99 (1893). *Type*: *Baeckea behrii* Schltdl. = *Hysterobaeckea behrii* (Schltdl.) Rye, lectotype, *fide* B.L. Rye, *Nuytsia* 25: 213 (2015).

Small to very tall *shrubs*, erect, often broome-like, glabrous, usually single-stemmed at the base and commonly multi-branched low down, sometimes ± at ground level, but with a lignotuber recorded for the Northern Territory species. *Young stems* with a whitish epidermis that is shed in strips, smooth in most species (sometimes with darker oil glands visible but not very prominent), tuberculate in *H. tuberculata*. *Leaves* opposite, often appressed or nearly so. *Petioles* well differentiated from the blade. *Leaf blades* entire, moderately to very thick; abaxial surface deeply convex; adaxial surface with a line-like groove along the middle in most species. *Peduncles* 1–3-flowered. *Bracteoles* with sides incurved, usually acuminate or acute. *Pedicels* usually much shorter than the peduncles. *Hypanthium* cup-shaped, adnate to ovary for most of its length; adnate part dotted with oil glands (sometimes obscurely), somewhat to obviously rugose in fruit; free part becoming smooth in fruit. *Sepals* 5, entire, persistent after the petals are shed, in some species with the outer surface ridged or horned. *Petals* 5, widely spreading, much longer than sepals. *Stamens* 9–28 but commonly *c.* 20, fairly equally distributed in a circle or with gaps opposite the centre of the petals, geniculate at the top of the free filament such that the large connective gland and terminal thecae extend directly inwards towards the centre of the flower; filament often with a fairly broad base but slender above; anther with small, closely connate thecae, dehiscent by basally divergent short slits. *Ovary* inferior, 2- or 3-locular; placentas large, shortly stalked or ± sessile; ovules radial, 6–21 per loculus. *Style* deeply inset; stigma peltate in most species. *Fruits* dehiscent by 2 or 3 terminal valves or (in *H. occlusa*) indehiscent. *Seeds* usually crustaceous and distinctly facetted, but only thinly crustaceous and unfacetted in *H. occlusa*, 0.7–2 mm long.

Size and distribution. As currently circumscribed, *Hysterobaeckea* extends from inland parts of the South West Botanical Province of Western Australia east to near Bendigo in Victoria and inland to the MacDonnell Ranges of the Northern Territory (Figure 1). Of the 12 species recognised here, nine are endemic to Western Australia and three occur further east.

Co-occurring species. Most members of this genus are geographically or ecologically separated from all others. Rock outcrop and sandplain species are separated by their habitat differences but may sometimes occur fairly close together. At one locality visited in 2004, *H. petraea* (*B.L. Rye* 241047 *& M.E. Trudgen*) grew in shallow soil at the edge of some sheet granite while *H. setifera* Rye occurred about 20 m downslope from the granite (*B.L. Rye* 241049 *& M.E. Trudgen*).

Among the sandplain taxa of south-western Australia, there is little or no overlap in their known distributions. The ranges of *H. longipes* Rye and *H. setifera* show the greatest overlap, although still largely distinct. No cases of co-occurrence are known.

Notes. The diameter of the base of the shrubs has not been measured for most species but is commonly 70–80 mm in *H. setifera* and has been recorded as up to 200 mm in *H. petraea*. Those two species can reach heights of over 3 m, with a maximum height of 4 m recorded for *H. petraea*.

Flower buds are often purplish or reddish on the hypanthium and sepals, with the exposed parts of the petals commonly deep pink. After the flowers open the petals are usually white inside (sometimes yellow-flowered in *H. ochropetala*), but with a splash of pink retained on the outside of the outer petals.

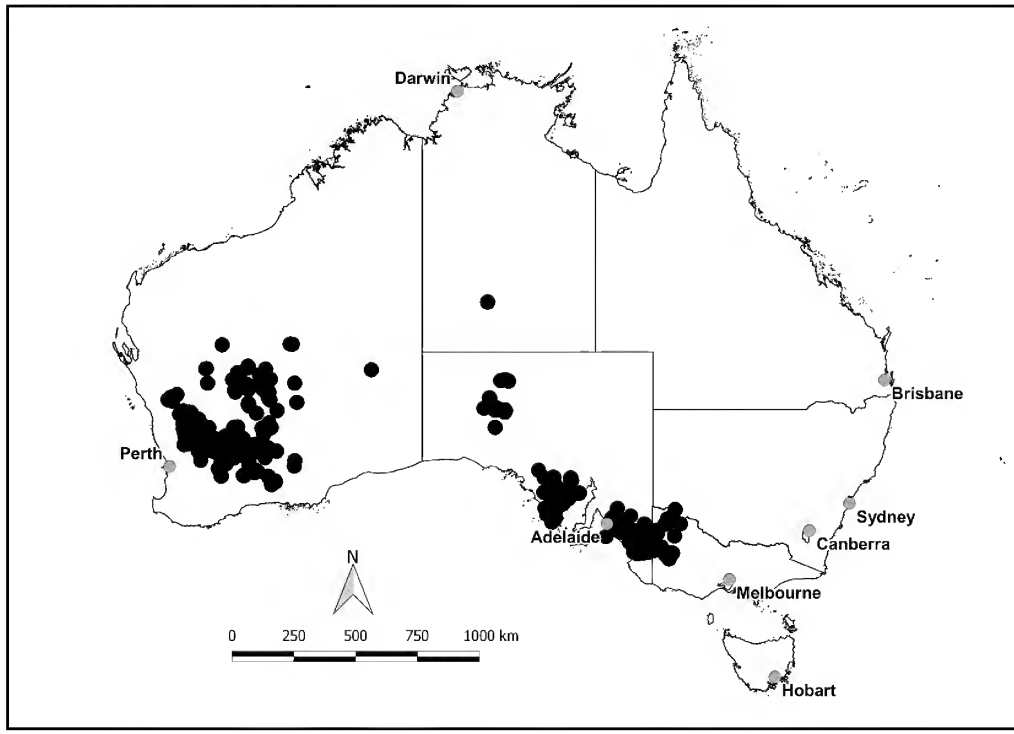

Figure 1. Distribution of *Hysterobaeckea*.

In mature fruits, the placentas are very broadly ovate to almost circular and usually 0.8–1.4 × 0.7–1.2 mm, with the abaxial surface highly raised except for a narrow rim, and with discrete circular attachment points of seeds around the lower part of the raised area. In most species the seeds have colliculate lateral surfaces and a small hilum. Chaff pieces (abortive seeds or unfertilised ovules) are usually similar to the seeds but somewhat smaller, and often darker.

Key to named species and subspecies of *Hysterobaeckea*

Note for use of key. When measuring the blade length and apical point of leaves, choose large leaves with the full point present, as the point tends to be partially lost as leaves age.

1. Ovary 2-locular in all or most flowers; ovules 6–9 per loculus

2. Leaves prominently tuberculate; apical point absent or less than 0.2 mm long. Bracteoles 1.5–1.8 mm long. Sepals *c.* 1 mm long, tuberculate towards the base. Fruits dehiscent by 2 valves (near Tallaringa Well–'Spanners Hwy', SA)..... **H. tuberculata**

2: Leaves not tuberculate; apical point 0.3–0.5 mm long. Bracteoles 0.6–0.8 mm long. Sepals 0.3–0.4 mm long, not tuberculate. Fruits indehiscent (Robinson Ra. area–Weld Ra.–near Leonora–S of Warburton, WA)..... **H. occlusa**

1: Ovary 3-locular in all or most flowers; ovules usually 9–21 per loculus

3. Leaves with an apical point 0.3–2.5 mm long

4. Leaves with an abaxial groove but no adaxial groove

5. Peduncles 1.5–3 mm long. Pedicels 0–1(–1.7) mm long. Petals 2.5–4 mm long (Mt Churchman–near Norseman, WA) ..... **H. petraea**

5: Peduncles 4–7 mm long. Pedicels 2–4.5 mm long. Petals 4–5 mm long (Fitzgerald Peaks area, WA) ..... **H. graniticola**

4: Leaves with an adaxial groove

6. Stamens 9–12. Mature style 0.8–1.5 mm long. Occurring in south-eastern Australia (Eyre Peninsula, SA–near Bendigo, Vic.) ..... **H. behrii**

6: Stamens usually 13–26 but down to 10 in *H. longipes*. Mature style 2.3–3.7 mm long. Occurring in south-western Australia

7. Sepals prominently horned. Leaves 2.5–3.5 mm long, with an apical point 0.3–1(–1.5) mm long (Die Hardy Ra.–Woongaring Hills–Bungalbin Hill, WA) ..... **H. cornuta**

7: Sepals sometimes prominently ridged but not horned. Leaves up to 15 mm long, rarely as short as previous choice, with an apical point 0.7–2.5 mm long

8. Leaves 9–15 mm long; adaxial furrow usually open although still narrow. Sepals rather petaline, without obvious glands, not ridged; apex very obtuse (Buntine–near Wyalkatchem, WA) ..... **H. longipes**

8: Leaves (2–)3–9 mm long; adaxial furrow usually closed and line-like. Sepals reduced and mostly herbaceous or larger and with obvious oil glands, usually ridged; apex obtuse or acute, sometimes with a point

9. Sepals 0.5–1.3 mm long. Leaves (2–)3–6 mm long; apical point 1.5–2.5 mm long (Remlap Stn–Narembeen, WA) ..... **H. setifera** subsp. **meridionalis**

9: Sepals 0.3–0.6 mm long (excluding apical point if one is present). Leaves 3.5–9 mm long; apical point 0.7–1.7 mm long (Pindar–Pithara–Mt Gibson Sanctuary, WA) ..... **H. setifera** subsp. **setifera**

3: Leaves without any point or with a mucro up to 0.1 mm long

10. Leaves with adaxial furrow partially developed or absent, when present only in basal half of blade. Sepals with a compressed, laterally projecting, dorsal ridge, which is about as deep as long. Ovules 9–13 per loculus (E of Hyden, WA) ..... **H. pterocera**

10: Leaves with adaxial furrow extending for most of length of blade. Sepals with little or no ridge in many cases, the ridge (when present) either thick or protruding apically as a horn, always longer than deep. Ovules usually 14–21 per loculus but down to 11 in *H. glandulosa*

11. Oil glands obvious on peduncles, pedicels and outside of flowers (hypanthium and sepals) as well as on leaves. Mature style 1.9–2.2 mm long. Ovules 11–15 per loculus (Karlgarin Hill area, WA) ..... **H. glandulosa**

11: Oil glands usually not obvious on all of the plant parts listed above. Mature style 2.5–4.5 mm long. Ovules 14–21 per loculus

12. Leaf blades 1.2–1.6 mm long; apex ± truncate. Flowers (where known) pale yellow (Diemals Stn area–Mt Moore–Jaurdi Stn, WA) ..... **H. ochropetala** subsp. **ochropetala**

12: Leaf blades 1.7–3.5 mm long in most specimens, sometimes 1.2–1.7 mm long in subsp. *reliqua*; apex obtuse on long-leaved specimens and usually also on short-leaved ones. Flowers white

13. Outer sepals moderately to markedly horned; horn 0.5–1.5 mm long. Petals 4–5.5 mm long. Stamens 19–28 (Comet Vale area, WA) ..... **H. ochropetala** subsp. **cometes**

13: Outer sepals unhorned or moderately horned; horn 0–0.6 mm long. Petals 3.3–4.5 mm long. Stamens 16–23 (E of Southern Cross–SW of Coolgardie–Taylor Rock, WA) ..... **H. ochropetala** subsp. **reliqua**

Western Australian species

Hysterobaeakea cornuta Rye, *sp. nov.*

Typus: south of Helena and Aurora Range, Western Australia [precise locality withheld for conservation reasons], 7 November 2000, *B.J. Lepschi & L.A. Craven* 4586 (*holo*: PERTH 06466613; *iso*: CANB 638980 *n.v.*).

Baeckea sp. Bungalbin Hill (B.J. Lepschi & L.A. Craven 4586), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Die Hardy Range (E. Mattiske J91), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Mt Jackson (G.J. Keighery 4362), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Shrub 0.7–1.8 m high, 0.9–3 m wide; flowering branchlets usually with 1 or 2 pairs of flowers, the leaves appressed or antrorse. *Petioles* 0.4–0.6 mm long. *Leaf blades* narrowly obovate in outline, 2.5–3.5 mm long, 0.9–1.1 mm wide, 0.7–1 mm thick, thick and recurved towards the apex, distinctly mucronate or pointed; abaxial surface with 2 or 3 main rows of very prominent oil glands on each side of midvein; adaxial surface with a line-like furrow extending at least half its length; mucrone or point somewhat to very recurved, 0.3–1(–1.5) mm long, whitish. *Peduncles* 4–10 mm long, 1(2)-flowered; secondary axes (when present) commonly 3.5–5 mm long. *Bracteoles* usually caducous or deciduous, 2–4 mm long, *c.* 0.3 mm wide, somewhat scarious. *Pedicels* 0.5–3(–5) mm long. *Flowers* 11–14 mm diam. *Hypanthium c.* 3.5 mm long, 4–5 mm wide; free portion *c.* 1 mm long. *Sepals* depressed-ovate, 0.8–1.5 mm long excluding horn and up to 2.7 mm long including it, *c.* 2 mm wide, with scarcely any pale-translucent margin, entire; horn projecting distally and incurved, bilaterally compressed, 1.2–2.5 mm long. *Petals* 4–4.5 mm long, white. *Stamens* 16–23, in a circle. *Longest filaments c.* 1.5 mm long, *c.* 0.2 mm wide at base. *Anthers* 0.3–0.4 mm wide from front view; connective gland *c.* 0.5 mm long; thecae *c.* 0.2 mm long. *Ovary* 3-locular; ovules 12–17 per loculus. *Style* 2.5–3.7 mm long; stigma up to 0.5 mm diam. *Fruits* more than half inferior, 4–5 mm long, 5.5–6 mm wide excluding the prominent calyx horns; hypanthium smooth in distal 0.8–1 mm. *Seeds* 1.2–1.3 mm long, 0.6–1 mm wide, 0.8–0.9 mm thick, pale brown to orange-brown; outer surface smooth to slightly colliculate.

Diagnostic characters. Among the species that have leaves with both an adaxial groove and an obvious apical point, *H. cornuta* is distinguished by having prominently horned sepals.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 14 Nov. 2003, *G. Cockerton* LCS8759 (PERTH); 24 Nov. 1981, *G.J. Keighery* 4362 (PERTH); 6 Dec. 2004, *Landcare Services* LCH 12159 (PERTH); 6 Nov. 2000, *E. Mattiske* J91 (PERTH); 20 Nov. 2007, *G. McLean & F. Faria* LCS 15987 (PERTH); 24 Sep. 1981, *K.R. Newbey* 8997 (PERTH); 7 Dec. 2010, *S. Reiffer* SRE 511 (PERTH); 21 Nov. 2010, *K.R. Thiele* 4089 (PERTH); 14 Nov. 2006, *W.A. Thompson* WAT 75 (PERTH).

Distribution and habitat. Recorded from sandplain areas, extending from near Die Hardy Range south-west to Woongaring Hills and south-east to Bungalbin Hill (Figure 2), commonly in yellow sand, often with lateritic gravel.

Phenology. Flowers mainly from October to December. Mature fruits recorded in November and December.

Conservation status. Variably listed under three phrase names by Smith and Jones (2018) as Priority Three (*B.* sp Bungalbin Hill) and Priority One (*B.* sp. Die Hardy Range and *B.* sp. Mt Jackson). The species will be maintained under Conservation Codes for Western Australian Flora as Priority Three.

Etymology. From the Latin *cornutus* (horned), referring to the markedly horned sepals.

Affinities. This is one of the core-group species. It may be closest to the *H. ochropetala* complex but is like *H. setifera* in having an obvious apical point on its leaves.

Variation. Most specimens have been housed under the name *B.* sp. Bungalbin Hill. One of them, *S. Reiffer* SRE 203, has leaves with an unusually long apical point, up to about 1.5 mm long. Otherwise the degree of variation within the material placed here is relatively small.

Baeckea sp. Die Hardy Range and *B.* sp. Mt Jackson were applied respectively to *E. Mattiske* J91 and *G.J. Keighery* 4362, neither of which shows any obvious distinguishing features in comparison to specimens housed as *B.* sp. Bungalbin Hill.

Notes. Plant width in the above description is based on two specimen records. Flower buds are prominently 5-horned at the summit in *H. cornuta*, and the sepal horns are also obvious in fruit.

Hysterobaeckea glandulosa Rye, *sp. nov.*

Typus: N of Kondinin-Hyden Road, Western Australia [precise locality withheld for conservation reasons], 4 November 2004, *B.L. Rye* 241159 *& M.E. Trudgen* (*holo*: PERTH 07218451; *iso:* CANB, K, MEL, NSW).

Baeckea sp. Kalgarin Hill Road (A.M. Lyne, L.A. Craven & F. Zich AML 1018), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Shrub 0.5–2 m high, 0.35–3 m wide, with prominent glands on young stems, peduncles and pedicels; flowering branchlets with 1 or occasionally 2 pairs of flowers, the leaves appressed or antrorse. *Petioles* 0.3–0.5 mm long. *Leaf blades* oblong-elliptic or broadly so in outline, 2.2–3 mm long, 1.1–1.4 mm wide, 0.7–1.1 mm thick, obtuse, not or scarcely mucronate; abaxial surface with 2 or 3 main rows

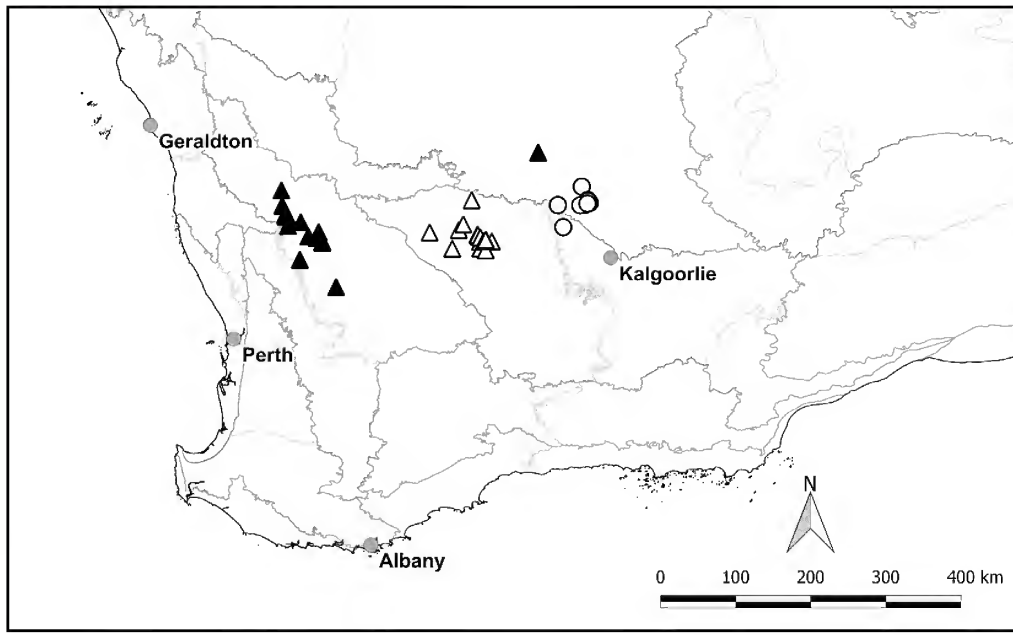

Figure 2. Distribution of *Hysterobaeckea cornuta* (△), *H. longipes* (▲) and *H. ochropetala* subsp. *cometes* (○).

of oil glands on each side of midvein; adaxial surface with a line-like furrow for most of its length. *Peduncles* 4–8 mm long, 1-flowered. *Bracteoles* deciduous, 1–1.5 mm long, 0.2–0.3 mm wide, largely scarious. *Pedicels* 2–5.5 mm long. *Flowers* 9–13 mm diam. *Hypanthium* 1.5–2 mm long, 2.5–2.8 mm wide, with prominent scattered oil glands but otherwise smooth in bud and remaining so or becoming more rugose in flower; free portion 0.6–0.9 mm long. *Sepals* depressed-ovate to triangular, 1–1.3 mm long, 1.1–1.6 mm wide, scarious, with a whitish margin *c.* 0.2 mm wide, slightly ridged but not horned, often with a dense grouping of prominent oil glands at the centre. *Petals* 3.3–4.5 mm long, white. *Stamens* 17–20, in a circle. *Longest filaments* 0.8–1.5 mm long, *c.* 0.2 mm wide at base. *Anthers* 0.3–0.35 mm wide from front view; connective gland 0.5–0.8 mm long; thecae 0.2–0.25 mm long. *Ovary* 3-locular; ovules 11–15 per loculus. *Style* 1.9–2.2 mm long; stigma 0.2–0.3 mm diam. *Fruits* largely inferior or *c.* half-inferior, *c.* 3 mm long, 4–4.5 mm wide; hypanthium smooth in distal 0.8–1.1 mm. *Seeds* apparently 0.9–1.2 mm long, at least 0.4 mm wide, *c.* 0.7 mm thick, pale to golden brown; outer surface smooth. (Figure 3A)

Diagnostic characters. Distinguished by the following combination of characters: leaves not or scarcely pointed, with an adaxial groove; hypanthium (also pedicel and peduncle) with prominent glands; sepals scarcely ridged but with prominent glands; ovules 11–15 per loculus; style about 2 mm long.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 4 Nov. 1992, *A.M. Lyne, L.A. Craven & F. Zich* AML 1018 (CBG *n.v.*, PERTH); 4 Nov. 2004, *B.L. Rye* 241162 *& M.E. Trudgen* (AD, BRI, PERTH); 4 Nov. 2004, *B.L. Rye* 241163 *& M.E. Trudgen* (PERTH).

Distribution and habitat. Known from the Karlgarin Hill area, between Kondinin and Hyden (Figure 4). Recorded from a gently undulating site with sandy soil and low open woodland.

Phenology. Flowers and fruits recorded in early November.

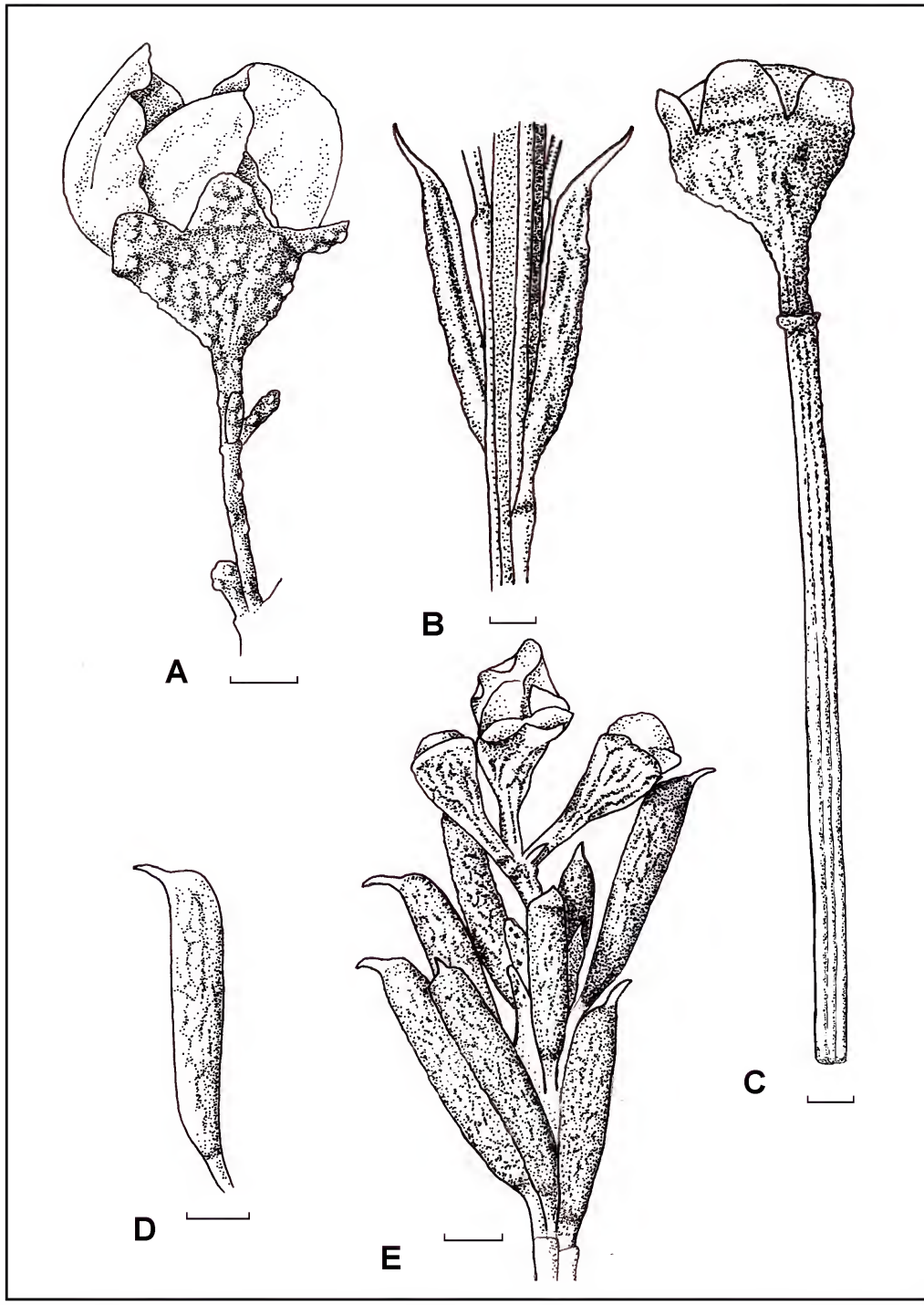

Figure 3. *Hysterobaeckea glandulosa*. A – late flower bud with pedicel, bracteoles and peduncle. *Hysterobaeckea longipes*. B – pair of leaves; C – flower bud, pedicel and long peduncle (bracteoles shed). *Hysterobaeckea occlusa*. D – leaf; E – flowering stem with three flower buds on a common peduncle. Scale bars = 1 mm. Drawn by Skye Coffey from *B.L. Rye* 241159 & *M.E. Trudgen* (A), *M.E. Trudgen* 5398 (B,C) and *B. Eckermann, H. Barwick, J. Warden & S. Burgess* LCS 18599 (D,E).

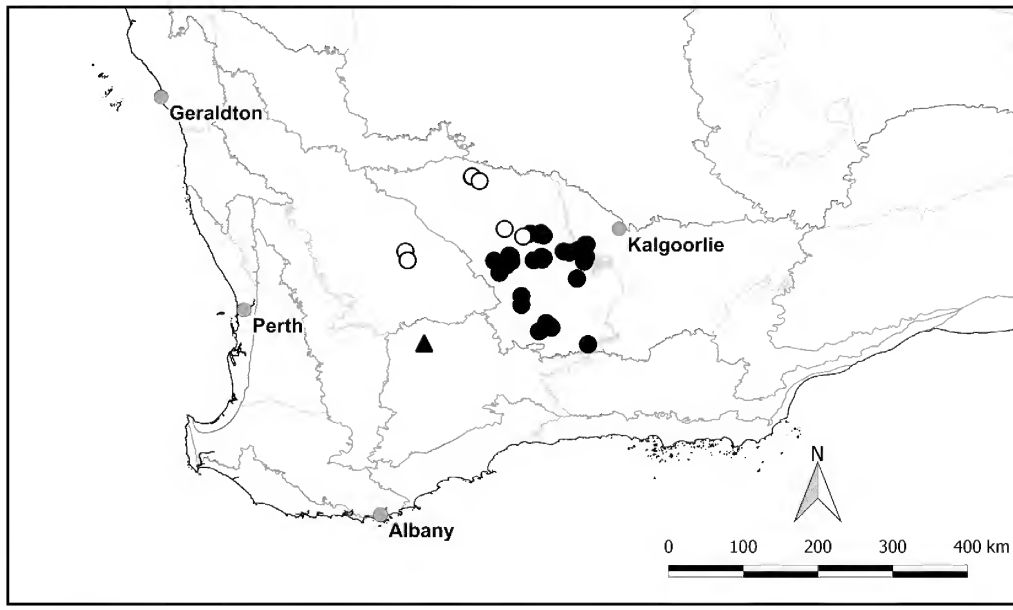

Figure 4. Distribution of *Hysterobaeckea glandulosa* (▲), *H. ochropetala* subsp. *ochropetala* (○) and *H. ochropetala* subsp. *reliqua* (●).

Conservation status. Recently listed as Priority One under Conservation Codes for Western Australian Flora under the phrase name *Baeckea* sp. Kalgarin Hill Road (A.M. Lyne 1018, L.A. Craven & F. Zich). The only known area of occurrence is less than 1 km long.

Etymology. The epithet, derived from the Latin *glandulae* (glands) and *–osus* (abounding in), refers to the presence of prominent glands on leaves, young stems, peduncles, pedicels and flowers (on the hypanthium and sepals). In other species that have prominent glands, the glands are usually less widely distributed.

Affinities. This species belongs to the *H. ochropetala* complex, which is treated here as comprising three named species, with *H. ochropetala* divided into three subspecies. *Hysterobaeckea glandulosa* is geographically isolated, occurring at the south-western extreme of the range of the complex in the least arid part of the range. It differs from other members of the complex in tending to have more obviously glandular peduncles and longer pedicels in relation to the length of the peduncles. It is closest to *H. pterocera* Rye in its style length and ovule numbers, but is readily distinguished, for example by its unhorned sepals (see notes under *H. pterocera*).

Notes. When the phrase name was established, Karlgarin was misspelt as Kalgarin because the original collection of this taxon, *A.M. Lyne* 1018, *L.A. Craven & F. Zich*, had the locality given with that spelling. A correction has now been made to the specimen.

As the above description is based on only four specimens, some of the quantitative characters may show a much greater range of variation within *H. glandulosa* than has been recorded so far. Two chaff pieces that probably were of roughly seed size were used to estimate the seed measurements given in the description.

Hysterobaeckea graniticola Rye, *sp. nov.*

Typus: Peak Charles, Western Australia, [precise locality withheld for conservation reasons], 28 September 1977, *R.J. Chinnock* 4183 (*holo*: PERTH 03411966; *iso*: AD *n.v.*, K).

Baeckea sp. Fitzgerald Peaks (P.J. Poli 53), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Shrub 1–2.5 m high, sometimes spreading up to 2.5 m wide, usually more erect; flowering branchlets usually with 1–4 pairs of flowers, the leaves appressed to moderately spreading. *Petioles* 0.8–1.1 mm long. *Leaf blades* narrowly oblong in outline, 6–9.5 mm long, 0.9–1 mm wide, 0.5–0.6 mm thick, with a recurved apical point; abaxial surface with 1 or 2 main rows of oil glands on each side of midvein, with a line-like furrow for most of its length; adaxial surface not furrowed; apical point 1–1.5 mm long. *Peduncles* 4–7 mm long, 1-flowered. *Bracteoles* caducous or deciduous, 2–2.3 mm long, 0.3–0.7 mm wide, largely scarious. *Pedicels* 2–4.5 mm long. *Flowers* 10–11 mm diam. *Hypanthium* 1.5–2.3 mm long, 2.5–3.5 mm diam.; free portion up to *c.* 0.5 mm long. *Sepals* depressed-elliptic, 1.5–1.8 mm long, 1.5–2.5 mm wide, deep pink with a narrow white margin, smooth or outermost one ridged. *Petals* 4–5 mm long, white. *Stamens* 14–16, in antisepalous groups of 2–4. *Longest filaments* 1.3–1.5 mm long, *c.* 0.3 mm wide at base. *Anthers* 0.35–0.5 mm wide from front view; connective gland 0.5–0.6 mm long; thecae 0.3–0.35 mm long. *Ovary* 3-locular; ovules 15–17 per loculus. *Style* 2–2.3 mm long; stigma 0.4–0.6 mm diam. *Fruits c.* 2/3 inferior, 2.5–3 mm long, 3–3.5 mm diam.; hypanthium smooth in distal 0.4–0.8 mm. *Seeds* 1–1.3 mm long, 0.5–0.6 mm wide, 0.7–0.75 mm thick, pale brown to orange-brown; outer surface smooth.

Diagnostic characters. Distinguished from all but two species in having leaves with an abaxial rather than an adaxial groove, and distinguished from those two species by the following combination of characters: leaf blades 6–9.5 mm long, peduncles 4–7 mm long, pedicels 2–4.5 mm long, petals 4–5 mm long and 15–17 ovules per loculus.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 24 Oct. 1964, *J.S. Beard* 3816 (PERTH); 21 Sep. 1985, *M.G. Corrick* 9471 (MEL, PERTH); 10 Nov. 1979, *K. Newbey* 6440 (NSW, PERTH); 18 Sep. 1985, *P.J. Poli* 53 (CANB, PERTH); 2 Nov. 1990, *R.W. Purdie* 3952 (CBG, PERTH).

Distribution and habitat. Occurs in the Fitzgerald Peaks region (Figure 5), on granite outcrops.

Phenology. Flowers recorded from September to November.

Conservation status. Listed by Smith and Jones (2018) as Priority Two under the name *B.* sp. Fitzgerald Peaks (P.J. Poli 53). This species is geographically restricted, being known from a single nature reserve.

Etymology. The epithet refers to the granitic habitat favoured by this species.

Affinities. This is a member of the *H. petraea* complex. It differs from *H. petraea* in having larger peduncles and pedicels, the latter sometimes being absent in *H. petraea*. It also tends to have longer (but less thickened) leaves and larger flowers.

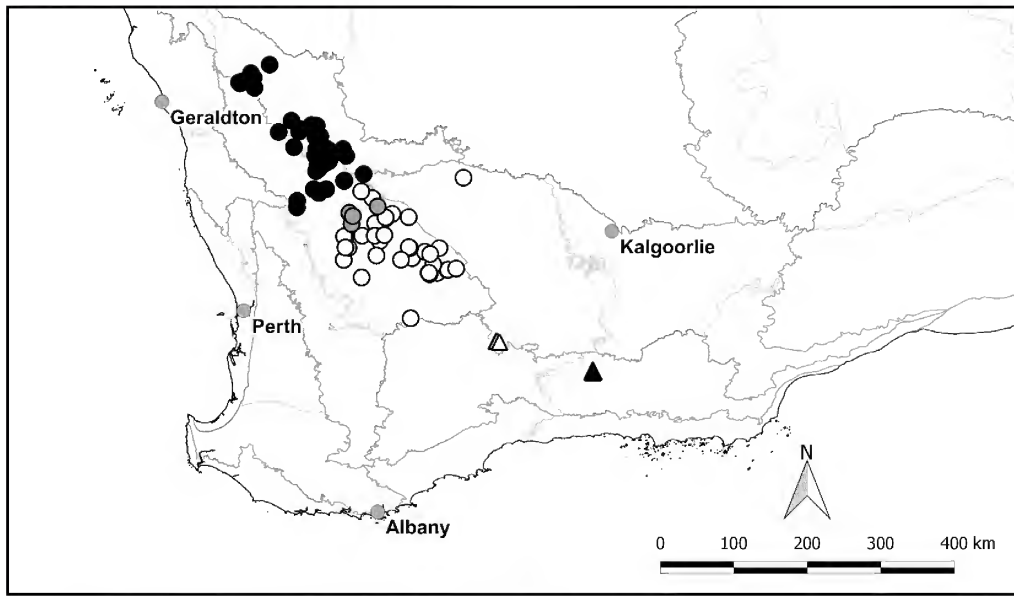

Figure 5. Distribution of *Hysterobaeckea graniticola* (▲), *H. pterocera* (△), *H. setifera* subsp. *meridionalis* (○), *H. setifera* subsp. *setifera* (●) and intermediates between the subspecies (◍).

Notes. This taxon could be treated as a subspecies of *H. petraea* as it is very similar to that taxon. However the morphological differences between the two taxa are clear-cut and there is an additional difference in leaf size in the southern area where both are found. The southernmost collection of *H. petraea* (*R.J. Cranfield* 10232) is close to the nature reserve where *H. graniticola* occurs. *Hysterobaeckea graniticola* has leaves 6–9.5 mm long whereas south-eastern specimens of *H. petraea* have leaves 3–5 mm long. Other specimens of *H. petraea* have leaves 3–6(–8) mm long.

Hysterobaeckea longipes Rye, *sp. nov.*

Typus: 7 miles [11 km] north-east of Wubin, Western Australia, 12 November 1986, *M.E. Trudgen* 5398 (*holo*: PERTH 06218849; *iso*: CANB, K, MEL, NSW).

Baeckea sp. Wubin (M.E. Trudgen 5404), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 348 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Shrub 0.9–3 m high, 0.6–2.5 m wide; flowering branchlets with 1–3 pairs or groups of flowers, the leaves appressed or antrorse. *Petioles* 1–1.6 mm long. *Leaf blades* linear in outline, 9–15 mm long, 0.5–0.8 mm wide, 0.5–1 mm thick, with a recurved apical point; abaxial surface with *c.* 3 main rows of oil glands on each side of midvein (although the glands and midvein often scarcely visible as the surface is wrinkled in dried leaves); adaxial surface with the furrow narrow but open and extending for its full length; point 1.5–2.3 mm long. *Peduncles* (6–)12–26 mm long, 1–3-flowered; secondary axes (when present) 5–10 mm long. *Bracteoles* caducous, 2–3.3 mm long, 0.2–0.4 mm wide, largely scarious. *Pedicels* 1.6–5.5 mm long. *Flowers* 10–13.5 mm diam. *Hypanthium* 2.3–3.5 mm long, 3–4 mm wide; free portion 0.7–1.1 mm long. *Sepals* depressed-ovate to very depressed-elliptic, 0.5–1.4 mm long, 1.8–2.5 mm wide, rather petaline, pink-tinged. *Petals* 3.5–5.25 mm long, white. *Stamens* 10–21,

usually in a circle. *Longest filaments* 1.5–2.3 mm long, 0.2–0.3 mm wide at base. *Anthers c.* 0.5 mm wide from front view; connective gland *c.* 0.6–0.7 mm long; thecae *c.* 0.3 mm long. *Ovary* 3-locular; ovules 8–11 per loculus. *Style* 3–3.5 mm long; stigma 0.2–0.3 mm diam. *Fruits c.* 2/3-inferior, 3–3.5 mm long, 4–5 mm diam. excluding calyx and up to 6 mm diam. including calyx; hypanthium smooth in distal 0.6–1 mm. *Seeds or chaff pieces* 1.3–1.4 mm long, 0.6–0.8 mm wide, 0.8–1.1 mm thick, dark red-brown; outer surface minutely reticulate-pitted. (Figure 3B, C)

Diagnostic characters. Among the species that have leaves with an obvious apical point (1.5–2.3 mm long in this case), *H. longipes* is distinguished by the following combination of characters: appressed to spreading leaves with an adaxial groove, obtuse sepals, and dark seeds with the outer surface reticulate-pitted.

Selected specimens examined. WESTERN AUSTRALIA: Burakin, 3 Nov. 1987, *H. Demarz* 11929 (KPBG, PERTH); Petrudor Rock Reserve, SE of Dalwallinu off main N–S track *c.* 500 m S of picnic area, 7 Nov. 1999, *M. Hislop* 1852 (PERTH); S side of Nugadong East Rd, *c.* 25 km NE of Dalwalinu, 11 May 1996, *M. Hislop* 296 *& J.P. Orsini* (PERTH); Wubin east, 22 Dec. 1962, *F. Lullfitz* L 2030 (PERTH); S of Wyalkatchem, 14 Nov. 1963, *S.B. Rosier* 409 (PERTH); Taylor Rd, 0.2 km W of Old Well Rd, E of Latham, 13 Oct. 2003, *B.L. Rye & M.E. Trudgen* BLR 231026 (DNA, PERTH); 2.4 km S of Wubin, 13 Oct. 1983, *C.I. Stacey* 739 (PERTH); Dalwallinu, 9 Nov. 1961, *Mrs Strickland s.n.* (PERTH); Dalwallinu–Kalannie Rd, 300 m W of Birdwood Rd and 13 miles [21 km] from Dalwallinu, 13 Nov. 1986, *M.E. Trudgen* 5407 (AD, BRI, PERTH).

Distribution and habitat. Extends from Buntine Nature Reserve south-east to near Burakin, with an inexplicable outlier at Mt Ida (Figure 2). Occurs in sandy soils, sometimes with gravel, the sand often yellow. Associated species often include *Allocasuarina*, *Acacia*, *Eucalyptus*, *Melaleuca* and *Grevillea*.

Phenology. Flowers recorded from late October to December.

Conservation status. Not currently considered to be at risk.

Etymology. From the Latin *longus* (long) and *pes* (foot), referring to the long peduncles (see Figure 3C). The peduncles are up to 26 mm long, although they have been observed to be as little as 3 mm long in a few fruits on a specimen that had mostly much longer peduncles. Among the other members of the large *Hysterobaeckea* group of genera, the greatest peduncle length known is 23 mm, recorded in *Scholtzia spatulata* (Turcz.) Benth.

Affinities. This species could be confused with *H. setifera*. It occurs mainly west of the distribution of *H. setifera* but there is some overlap. It differs from *H. setifera* in its usually longer leaves, with the adaxial groove not closed, and the oil glands tending to be less prominent. Differences in its sepal morphology are as indicated in the key.

Good fruiting material is still needed for *H. longipes*; the best available specimen (*F. Lullfitz* L 2030) has a good number of apparently full-sized, but empty seeds, which are either immature or actually chaff pieces. The immature seeds or chaff pieces observed so far are darker than those in related taxa and also distinctive in their patterning, which is minutely reticulate-pitted over the three main surfaces. *Hysterobaeckea longipes* has maroon ovules, which may be related to this distinct seed colour.

Notes. The leaves of *H. longipes* are the longest in the genus and the longest in all Western Australian species of the *Hysterobaeckea* group of genera. Outside Western Australia, the longest leaves for this group are found in *Sannantha pluriflora* (F.Muell.) Peter G.Wilson.

Stamen numbers are particularly variable in this species, with up to 21 stamens per flower but occasionally as few as ten.

Hysterobaeckea occlusa Rye, *sp. nov.*

Typus: east side of Mt Richardson, Western Australia, 10 December 2008, *B. Eckermann, H. Barwick, J. Warden & S. Burgess* LCS 18599 (*holo*: PERTH 08470316; *iso*: CANB, K, MEL).

Baeckea sp. Melita Station (H. Pringle 2738), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 348 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Mt Clifford (B. Severne 74002), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Thryptomene sp. Leinster (G. Cockerton 1534), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 404 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Shrub 0.7–3 m high, up to 2.5 m across; flowering branchlets with 1–3 pairs of peduncles, the leaves mostly antrorse or moderately spreading. *Petioles* 0.4–0.6 mm long. *Leaf blades* narrowly obovate in outline, 2.5–5 mm long, 0.5–1 mm wide, 0.8–1.1 mm thick, with a recurved apical point; abaxial surface with numerous oil glands (not or scarcely in rows) on each side of midvein; adaxial surface not furrowed; apical point 0.3–0.5 mm long, white. *Peduncles* 1–3.5 mm long, 1–3-flowered, commonly 3-flowered; secondary axes 0–0.6 mm long. *Bracts and bracteoles* caducous or deciduous, 0.6–0.8 mm long, 0.2–0.4 mm wide, scarious. *Pedicels* 0.6–1.1 mm long. *Flowers* 4.5–6 mm diam. *Hypanthium* 1.4–1.5 mm long, 2–3 mm wide, densely glandular; free portion 0.4–0.7 mm long. *Sepals* 0.3–0.4 mm long, 1–1.5 mm wide, with a whitish border *c.* 0.2 mm wide, not ridged or horned. *Petals* 1.5–1.8 mm long, white. *Stamens* 15–20, in antisepalous groups of 2–5. *Longest filaments* 0.5–0.6 mm long, 0.15–0.25 mm wide at base. *Anthers* 0.3–0.4 mm wide from front view; connective gland *c.* 0.3 mm long; thecae 0.2–0.25 mm long. *Ovary* 2-locular; ovules 6–9 per loculus. *Style* 0.8–1 mm long; stigma *c.* 0.2 mm diam. *Fruits* indehiscent, inferior, 1.5–2 mm long, 2–2.5 mm diam.; hypanthium sometimes smoother in the distal 0.4 mm but often without any smooth part visible. *Seeds* irregularly rounded (e.g. ± very broadly elliptic) in outline, not facetted, 0.9–1.2 mm long, 0.8–0.9 mm wide, *c.* 0.5 mm thick, whitish; outer surface with some slight folds but otherwise smooth. (Figure 3D, E)

Diagnostic characters. Distinguished from other species of *Hysterobaeckea* in having an indehiscent fruit and the connective gland scarcely longer than the anther thecae. It is the only species apart from *H. tuberculata* that has a 2-locular ovary.

Selected specimens examined. WESTERN AUSTRALIA: 144 km E of Mount Magnet [near Sandstone], S side of road just E of parking area, 31 Jan. 2005, *D. Brinsden* 3 (PERTH); just W of central Yandal Stn, 9 km NNW from the geological Mt McClure, 17 Dec. 1998, *D. Hirschberg s.n.* (PERTH); *c.* 90 km S of Warburton, 20 Sep. 2010, *J. Jackson* 187 (PERTH); SW corner of proposed Ida Valley

Conservation Park, 3 Apr. 2007, *B. Jeanes s.n.* (PERTH); Booylgoo Spring Stn, *c.* 5.2 km NE of Mt St Michel and 5.8 km NW of Garden Well, Booylgoo Range, 7 Sep. 2006, *A. Markey & S. Dillon* 4686 (PERTH); Robinson Range, 17 Aug. 2006, *R. Meissner & B. Bayliss* 793 (NSW, PERTH); Melita Stn, 5 Dec. 1989, *H. Pringle* 2738 (PERTH); Weld Range, 10 Mar. 2009, *G. Turner* 806702 (PERTH).

Distribution and habitat. A wide distribution in the arid zone, extending from the Robinson Range area (north of Meekatharra) south to Melita Station (near Leonora) and from Weld Range east to south of Warburton (Figure 6), mostly associated with ironstone hills, often with *Acacia* and *Eremophila*. This distribution is well inland of, and much larger than, the ranges of all of the other Western Australian species.

Phenology. Flowers probably at any time of the year, whenever conditions in this arid region are suitable.

Conservation status. Not considered to be at risk, its known range extending for about 1,000 km from west to east.

Etymology. From the Latin *occlusus* (closed, shut), referring to the indehiscent fruits.

Affinities. This highly distinctive species differs from the other three rock-occupying species, *H. graniticola*, *H. petraea* and *H.* sp. Mt Zeil, in lacking an abaxial groove on the leaves, and differs

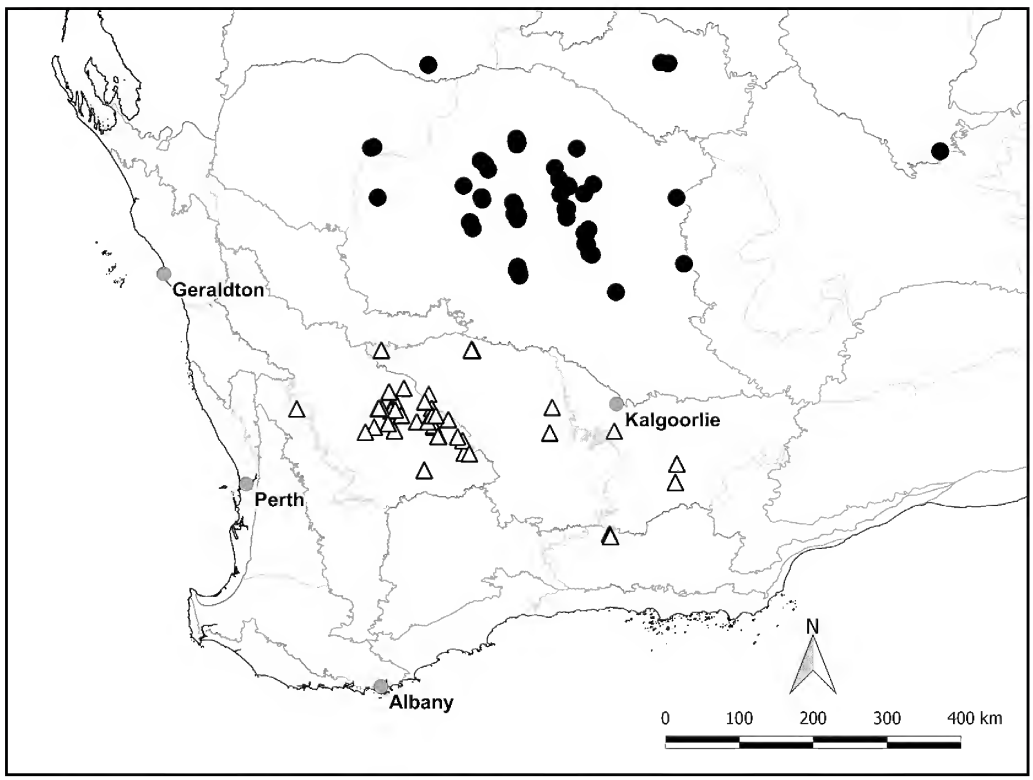

Figure 6. Distribution of *Hysterobaeckea occlusa* (●) and *H. petraea* (△).

from the core group species of *Hysterobaeckea* in lacking an adaxial groove on the leaves. It also differs from all species in having an indehiscent fruit, and from all except *H. tuberculata* in having a 2-locular ovary.

Variation. The single specimen, *B. Severne* 74002, that has been named *Baeckea* sp. Mt Clifford has mature fruits but no flowers. Its leaves are more shrunken than usual so may be drought-stressed. Otherwise *H. occlusa* is not particularly variable considering how wide its distribution is.

Notes. Most of the collections of *H. occlusa* are sterile, and those with flowers are not very well pressed, so there may be inadequacies in the description of flowers given above. Mature seeds were also examined on only a few specimens. Nearly all of the specimens have galls, the most common kind being a more or less ovoid, verrucose gall that appears to have been formed by the fusion of two pairs of abnormally broad leaves at the apex of a shoot. No galls of this kind have been observed on the other species described here, although other kinds of galls are common.

At maturity the indehiscent fruits tend to have the two loculi protruding somewhat at the top, resulting in two parallel swellings on either side of the style. Sometimes the fruits contain an insect larva, probably of a wasp, in a somewhat enlarged seed and loculus, as on *A. Markey & S. Dillon* 4686. Commonly one seed is produced in each loculus and the usually dark red-brown chaff pieces are very compressed; however, if a single seed does not develop the chaff pieces may enlarge, becoming pale, facetted, seed-like and *c.* 1.75 mm long.

Hysterobaeckea ochropetala (F.Muell.) Rye, *Nuytsia* 25: 215 (2015). *Baeckea ochropetala* F.Muell., *Fragm.* 10: 29 (1867). *Type*: between Ularring Rock and Mt Jackson, Western Australia, 17–20 October 1875, *J. Young s.n.* (*lecto*: MEL 72891, *fide* B.L. Rye, *Nuytsia* 25: 215 (2015); *isolecto*: K 00082139).

Illustration. W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.* 3A: 79 (1980) [as *Baeckea ochropetala*], apparently showing the typical subspecies and at least one of the other subspecies.

Shrub 0.3–2 m high, 0.35–3 m wide; flowering branchlets with 1 or occasionally 2 pairs of flowers, the leaves appressed or antrorse. *Petioles* 0.2–0.8 mm long. *Leaf blades* narrowly oblong to almost circular in outline, 1.2–3.5 mm long, 0.8–1.5 mm wide, 0.6–1.3 mm thick, sometimes with an erect to recurved mucro up to 0.1 mm long; abaxial surface with 1–3 main rows of oil glands on each side of midvein, although there are often very few glands; adaxial furrow usually line-like for most of its length. *Peduncles* (1–)2–14 mm long, 1-flowered. *Bracteoles* caducous to persistent, 0.8–3 mm long, 0.2–1 mm wide, usually largely scarious. *Pedicels* 0–4.5 mm long. *Flowers* 9–15 mm diam. *Hypanthium* 2.3–4 mm long, 3–6 mm wide; free portion 0.7–1.2(–1.5) mm long. *Sepals* depressed-triangular to almost semicircular, usually ± depressed-ovate, usually 0.7–1.3 mm long but up to 2 mm long when horned, 1.5–2.5(–3) mm wide, with a somewhat scarious margin 0.2–0.3 mm wide, the outer sepals somewhat ridged to prominently horned; horn (when present) projecting distally and incurved, bilaterally compressed, up to 1.5 mm long. *Petals* 3–5.5 mm long, white or pale yellow. *Stamens* 16–28, in a circle. *Longest filaments* 0.7–1.6 mm long, mostly 0.25–0.4 mm wide at base. *Anthers* 0.3–0.6 mm wide from front view; connective gland 0.5–0.8 mm long; thecae 0.2–0.4 mm long. *Ovary* 3-locular; ovules 14–21 per loculus. *Style* 2.5–4.5 mm long; stigma 0.3–0.5 mm diam. *Fruits* largely inferior or *c.* half-inferior, 3–4.5 mm long, 3.5–5.5 mm wide excluding the sometimes widely spreading calyx; hypanthium smooth in distal 0.7–1.6 mm. *Seeds* 0.8–1.4 mm long, 0.5–0.8 mm wide, 0.5–0.9 mm thick, pale to golden brown; outer surface smooth.

Diagnostic characters. Distinguished from all other species of *Hysterobaeckea* in the following combination of characters: leaves with a long, line-like abaxial groove but with no apical point or just a mucro up to 0.1 mm long; sepals with horn absent or up to 1.5 mm long; style 2.5–4.5 mm long; ovules 14–21 per loculus.

Distribution. Extends from the Diemals Station area east to the Comet Vale area, south-west to Mt Moore and south-east to Taylor Rock.

Notes. This species was incorrectly treated as a variety of *Babingtonia grandiflora* (Benth.) Rye in Blackall and Grieve (1954: 289) under the invalid name *Baeckea grandiflora* var. *ochropetala* W.E.Blackall, although it was included as *B. ochropetala* in a later edition (Blackall & Grieve 1980: 79).

Hysterobaeckea ochropetala is an extremely variable taxon, belonging to a larger complex that encompasses *H. glandulosa*, *H. pterocera* Rye and the poorly known *H.* sp. Exclamation Lake. Three subspecies are tentatively recognised in order to reflect some of this variation, although a few specimens appear to be intermediate between the extremely variable subsp. *reliqua* Rye and the other two, less variable subspecies. Future collecting in the central wheatbelt to goldfields area could clarify this picture, by establishing the full extent of the yellow-flowered variant and other variants, and by determining whether intermediates reflect clinal variation or whether hybridisation is responsible for some of the blurring of boundaries in this complex.

The brief description of *H. ochropetala* given by Rye (2015a) applies only to typical specimens, treated here as subsp. *ochropetala*.

Hysterobaeckea ochropetala subsp. **cometes** Rye, *subsp. nov.*

Typus: Comet Vale, Western Australia [precise locality withheld for conservation reasons], 27 September 1966, *A.S. George* 8078 (*holo*: PERTH 03415805; *iso*: MEL).

Baeckea sp. Comet Vale (A.S. George 8078), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Illustration. Drawings on *C.A. Gardner* 2082.

Petioles 0.5–0.7 mm long. *Leaf blades* oblong to broadly obovate in outline, 2.2–3.5 mm long, 0.8–1.3 mm wide, 0.6–0.9 mm thick, obtuse. *Peduncles* 3–14 mm long. *Bracteoles* 1.5–3 mm long. *Pedicels* 1–3.5 mm long. *Flowers* 12–15 mm diam. *Hypanthium* tending to have large prominent oil glands. *Sepals* 0.7–1.1 mm long excluding horn and up to 2 mm long including it; horn 0.8–1.5 mm long. *Petals* 4–5.5 mm long, white. *Stamens* 19–28. *Longest filaments* 1.2–1.6 mm long. *Ovules* 15–21 per loculus. *Style* 3.5–4.2 mm long. *Seeds* 1.3–1.4 mm long. (Figure 7A–D)

Diagnostic characters. Subspecies *cometes* is distinguished from the other two subspecies by its larger flowers, with white petals 4–5.5 mm long and prominently horned sepals.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] Sep. 1927, *W.E. Blackall s.n.* (PERTH); 5 July 1995, *R.J. Cranfield* 9850 (PERTH); 13 June 2008, *D.J. Edinger* 6752 (PERTH); 9 Sep. 1927, *C.A. Gardner* 2802 (PERTH); 7 Sep. 2011, *N. Gibson & M.A. Langley* 5295 (PERTH); 1980, *A.V. Milewski* AVM 20A (AD, PERTH); 13 Sep. 1966, *K.R. Newbey* 2585 (PERTH); 25 Sep. 1991, *Peter G. Wilson* 1250 *& R. Rowe* (PERTH).

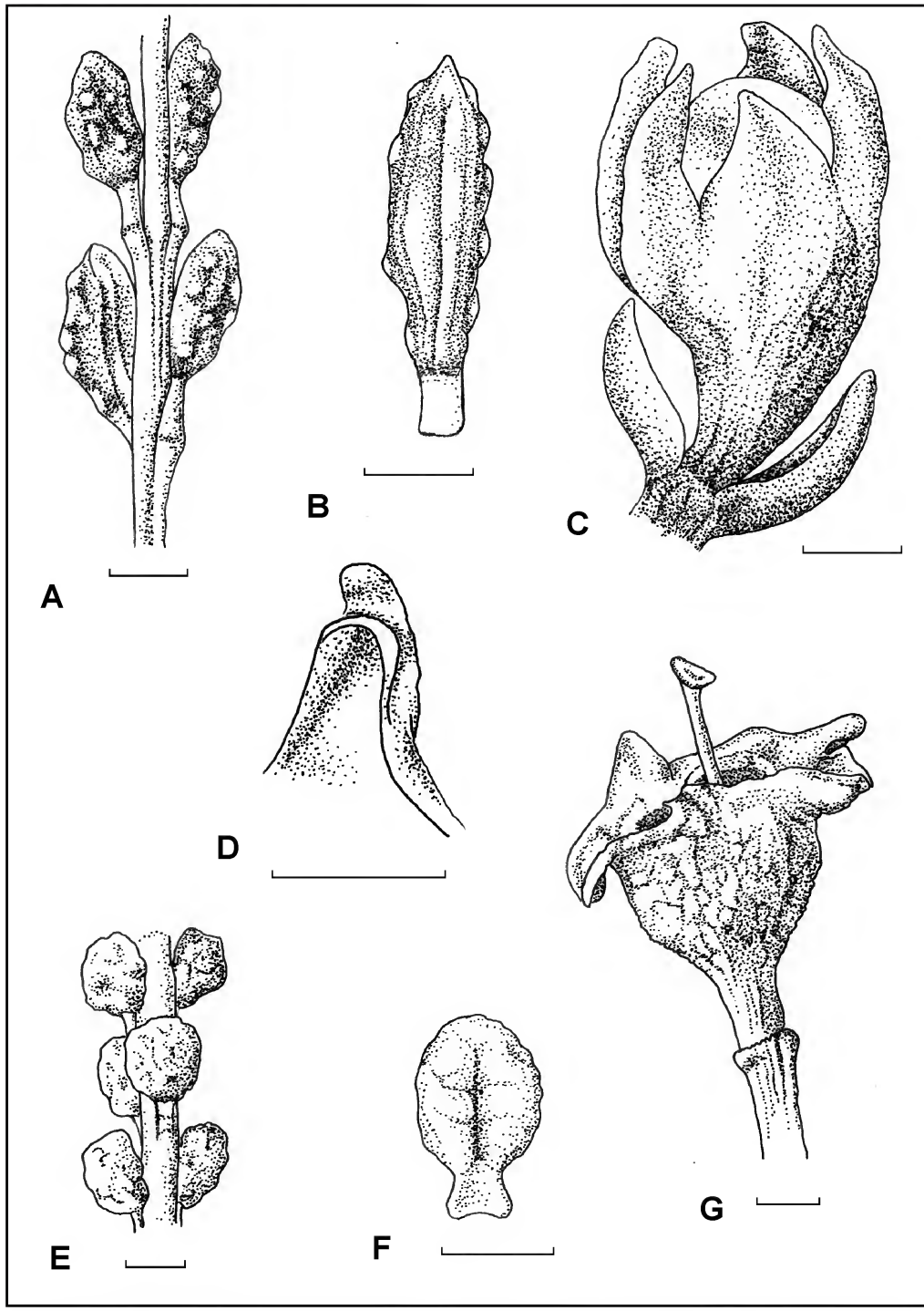

Figure 7. *Hysterobaeckea ochropetala* subsp. *cometes*. A – opposite leaves, with pedicels up to half as long as the blades; B – adaxial surface of leaf; C – horned flower bud with bracteoles (soaked), D – horned sepal (soaked). *Hysterobaeckea ochropetala* subsp. *ochropetala*. E – opposite leaves; F – adaxial surface of leaf; G – young fruit with pedicel and peduncle. Scale bars = 1 mm. Drawn by Skye Coffey from *A.S. George* 8078 (A, B), *P.G. Wilson* 1250 (C, D) and *B.L. Rye* 241066 & *M.E. Trudgen* (E–G).

Distribution and habitat. Occurs in the Comet Vale area (Figure 2) in sandy soils, often red or yellow, the dominant vegetation often of mallees over *Acacia* species, with an understory of spinifex.

Conservation status. Recently listed by Smith and Jones (2018) as Priority Three under Conservation Codes for Western Australian Flora, under the name *Baeckea* sp. Comet Vale (A.S. George 8078). The taxon is geographically restricted and possibly not recorded from any conservation reserves. The distribution is *c.* 60 km long, or *c.* 70 km long if the record (*W.E. Blackall s.n.*) from Menzies is reliable.

Phenology. Flowers recorded from July to September and mature fruits in early July.

Etymology. From the Latin for comet (*cometes*), a noun in apposition, as this species is restricted to the Comet Vale area.

Notes. Subspecies *cometes* occurs in the north-eastern part of the range of *H. ochropetala*. It has, on average, the largest flowers and the most numerous stamens in the genus. The prominent horns on its sepals cause the flower buds and young fruits to be 5-horned.

Hysterobaeckea ochropetala (F.Muell.) Rye subsp. **ochropetala**

Baeckea sp. Lake Brown (E. Merrall s.n. 1889), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Petioles 0.2–0.5 mm long. *Leaf blades* broadly oblong-elliptic to almost circular in outline, 1.2–1.6 mm long, 1–1.5 mm wide, 1–1.3 mm thick, ± truncate. *Peduncles* 2–5 mm long. *Bracteoles* 1.3–2.2 mm long. *Pedicels* 0.4–1.3(–3) mm long. *Flowers c.* 10 mm diam. *Hypanthium* rugose in late bud, the oil glands often sunken and not particularly obvious. *Sepals* 0.8–1.5 mm long, the outer ones somewhat ridged. *Petals c.* 3.5 mm long, usually pale yellow. *Stamens* 16–25. *Longest filaments c.* 1.5 mm long. *Ovules* 14–17 per loculus. *Style* 2.5–3.8 mm long. *Seeds c.* 1.1 mm long. (Figure 7E–G)

Diagnostic characters. Distinguished from the other subspecies of *H. ochropetala* by its uniformly short, more or less truncate leaves. Unlike the other subspecies, this taxon often has yellow flowers.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 19 Oct. 2011, *J. Jackson* 240 (PERTH); 16 Nov. 2010, *M. Maier & B. Eckermann* MM 1048 a (AD, PERTH); 1889, *E. Merrall s.n.* (MEL 76410); 1889, *E. Merrall s.n.* (MEL 73147); 25 Sep. 2013, *W.P. Muir* WPM 3346 (K, PERTH).

Distribution and habitat. Extends from the Diemals Station area south-west to Mt Moore and south-east to Jaurdi Station (Figure 4). Occurs in yellow sand or other sandy habitats, some records being of sand over laterite.

Phenology. Flowers and fruits August to November.

Conservation status. Listed as Priority Two by Smith and Jones (2018) under the names *H. ochropetala* and *B.* sp. Lake Brown (E. Merrall s.n. 1889). Occurs in several reserves including the wildlife sanctuary that includes Boordarding Rock and Split Rocks.

Variation. The name *B.* sp. Lake Brown was applied to two MEL specimens in the far west of the distribution, separated by more than 100 km from the closest populations in the remainder of the range of *H. ochropetala*. In addition to their geographical isolation these specimens have the shortest petioles recorded in the *H. ochropetala* complex, down to 0.2 mm long. However, both specimens of *B.* sp. Lake Brown comprise small pieces of stem so may not represent this western variant well, and both are in early bud. Recent searches in the Lake Brown area, have failed to locate any populations. Consequently, the petal colour and quantitative floral characters of the *B.* sp. Lake Brown variant remain unknown.

Notes. Subspecies *ochropetala* differs from all other members of the genus *Hysterobaeckea* in having yellow petals on the type (Mueller 1876). It occurs in the north-western part of the distribution of *H. ochropetala*, well separated from subsp. *reliqua* except in the vicinity of Jaurdi Station (see Figure 4). Its very short, thick leaves have a more or less truncate apex, which may be somewhat pinched in at the middle, in contrast to the obtuse apex found in the two other subspecies.

Flower buds are scarcely lobed or obtusely 5-lobed at the summit in subsp. *ochropetala*. Previously the style length was recorded as *c.* 1.5 mm (Rye 2015a) but that was based on a single measurement obtained from a specimen that did not have any fully mature styles. Mature styles 2.5–3.8 mm long have now been measured. However, the floral measurements recorded here for subsp. *ochropetala* are still based on very little material, while seeds have been found on only one specimen.

Hysterobaeckea ochropetala subsp. **reliqua** Rye, *subsp. nov.*

Typus: Goldfields Woodlands Conservation Park, *c.* 40 km south of Coolgardie on the Victoria Rock road, Western Australia, 20 December 2012, *J. Jackson* 260 (*holo*: PERTH 08670005; *iso*: K, MEL).

Baeckea sp. Boorabbin (J.H. Willis s.n. 4/10/1961), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Bulla Bulling (D.J.E. Whibley 4648), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Coolgardie (A. Strid 21320), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Gnarlbine Rocks (G. Barrett GRH 469), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Mt Clara (R.J. Cranfield 11693), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Queen Victoria Rock (K.R. Newbey 6103), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Roundtop Hill (P. Armstrong 05/843), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Ubini (R. Pullen 9610), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Petioles 0.35–0.8 mm long. *Leaf blades* oblong-elliptic to almost circular in outline, 1.2–2.5(–3.5) mm long, 0.8–1.3 mm wide, 0.7–1.3 mm thick, usually obtuse, sometimes truncate. *Peduncles* (1–)3–12 mm long. *Bracteoles* 0.8–2.2(–2.5) mm long. *Pedicels* (0–)1–3(–4) mm long. *Flowers* 9–13 mm diam. *Hypanthium* rugose throughout, usually even in young bud, the oil glands often sunken and not particularly obvious. *Sepals* 0.8–1.6 mm long, somewhat to markedly ridged or with a horn up to 0.6 mm long. *Petals* 3–4.5 mm long, white. *Stamens* 16–23. *Longest filaments* 0.7–1.4 mm long. *Ovules* 14–19 per loculus. *Style* 2.6–4.5 mm long. *Seeds* commonly 1.15–1.35 mm long.

Diagnostic characters. Distinguished from the other two subspecies by the combination of its mostly obtuse leaves, white petals 3–4.5 mm long, and ridged to moderately horned sepals.

Specimens examined of western, small-leaved variant. WESTERN AUSTRALIA: 25 km E of Southern Cross in gravel pit, 14 Oct. 1985, *J.M. Brown* 311 (PERTH); Yilgarn Breakaway, *c.* 150 km by road E of Hyden on Hyden–Norseman Track, 24 Apr. 2000, *G. Cockerton s.n.* (PERTH); 7 km NNE of Mt Clara, 2 Dec. 1997, *R.J. Cranfield* 11703 (PERTH); along State Vermin Fence No 7, between 45 and 65 km S of Great Eastern Hwy, 15 Oct. 1987, *J. Dodd* 420 (PERTH); Southern Cross, 23 Nov. 1962, *W. Middleton s.n.* (MEL); 11.9 km E of Yellowdine on Great Eastern Hwy, 15 Oct. 2004, *B.L. Rye* 241066 *& M.E. Trudgen* (CANB, K, MEL, NSW, PERTH); 3 km S of trans-Australian Railway line on Health Department Rd, N of Boorabbin, 12 Oct. 1999, *L.W. Sage & F. Hort* 2312 (PERTH); 18 km ENE of Marvel Loch, on the track to Mt Palmer Cemetery, 100 m from the north end, ESE of Southern Cross, 3 Dec. 2008, *M.E. Trudgen* 23355 B (AD, BRI, NSW, PERTH); half mile [0.8 km] W of Karalee [Rock, E of Southern Cross] on Great Eastern Hwy, 19 Sep. 1963, *J.H. Willis s.n.* (MEL); 11.9 km E of Yellowdine, 15 Oct. 1997, *P.G. Wilson* 1380 *& N. Lam* (PERTH).

Specimens examined with ridged or scarcely horned sepals. WESTERN AUSTRALIA: 20.2 miles [32 km] from Coolgardie towards Southern Cross, 8 Sep. 1968, *E.M. Canning s.n.* (PERTH); N of Great Eastern Hwy near Coolgardie, 16 July 2014, *L. Dadour* BCLD 18 (PERTH); 65 miles [105 km] W of Coolgardie, Mar. 1957, *P.R. Jefferies, D.E. White & J.W. Green* 573076 (PERTH); 24 km SSW of Queen Victoria Rocks, 25 Sep. 1979, *K.R. Newbey* 6103 (PERTH); Great Eastern Hwy, 21 km from Coolgardie towards Southern Cross, 10 Nov. 1982, *A. Strid* 21320 (PERTH).

Specimens examined with distinctly horned sepals. WESTERN AUSTRALIA: 7.7 km S of Gnarlbine Rocks, 28 Sep. 1992, *G. Barrett* GRH 469 (PERTH); *c.* 1.9 km N of Great Eastern Hwy, 16 km NE of Woolgangie, 13 Oct. 2011, *J. Nelson & R. Daniel* MW 11016–05 (PERTH); *c.* 18 km W of Coolgardie, 24 Nov. 1974, *R. Pullen* 9610 (PERTH); 10.6 km E of Boorabbin on Great Eastern Hwy, 15 Oct. 2004, *B.L. Rye* 241078 *& M.E. Trudgen* (NSW, PERTH); 10 km SW of Gnarlbine Rock, 15 Oct. 2004, *B.L. Rye* 241081 *& M.E. Trudgen* (AD, BRI, MEL, PERTH); 60 km WSW of Kalgoorlie [*c.* 20 km WSW of Coolgardie on Great Eastern Hwy], 30 Oct. 1974, *D.J.E. Whibley* 4648 (AD, PERTH).

Distribution and habitat. Extends from east of Southern Cross south-east to Roundtop Hill and Taylor Rock and east to near Queen Victoria Rocks (Figure 4). Occurs in yellow or brown sandy soils, sometimes in sand over laterite.

Phenology. Flowers from September to December, especially in October and November.

Conservation status. Not considered at risk. Several of the phrase names given above were previously listed as Priority One, while others were unlisted (Smith & Jones 2018). Currently the subspecies is known from many collections, including several from the vicinity of Boorabbin National Park and Lake Barker Wildlife Sanctuary, suggesting that it is relatively well protected, and its known range is more than 250 km long.

Etymology. From the Latin *reliquus* (leftover, remainder) as this taxon covers the remaining variants following the removal of the other two subspecies. In most respects the subspecies is intermediate between the other subspecies.

Variation. This particularly variable subspecies was previously split into eight phrase-named entities. Southern specimens tend to have a longer style (*c.* 4 mm) than the northern ones, while eastern ones have more variable leaves, which are longer on average than in the western specimens. The small-leaved variant that is common in the west of the range was given the phrase name *B.* sp. Mt Clara (R.J. Cranfield 11693) and shows the greatest approach to subsp. *ochropetala*, with which it may slightly overlap in range. A possibly intermediate specimen is *L.W. Sage & F. Hort* 2053 from Jaurdi Station, as this has short, more or less truncate leaves combined with white flowers.

Baeckea sp. Boorabbin (J.H. Willis s.n. 4/10/1961) is based on a sheet with three pieces attached. The piece on the right side of the sheet is a good match for the *B.* sp. Mt Clara variant, including a specimen (*T. Houston* 408-33) from near Boorabbin, except that all branches on the latter have tiny leaves whereas the former has a mixture of branches with tiny leaves and branches with somewhat longer leaves. Most leaves on the other two pieces of *J.H. Willis s.n.* are of the longer kind, although a few tiny leaves are present, and the sepals are somewhat horned (certainly more so than on the right branch and the *T. Houston* 408-33 specimen). Other relatively long-leaved collections from the Boorabbin area have more obviously horned sepals, such as *B.L. Rye & M.E. Trudgen* BLR 241077–241079, although specimens collected less than 1 km further along the road, *B.L. Rye & M.E. Trudgen* BLR 241073 & 241074, have sepals scarcely horned as in the left pieces of the *J.H. Willis s.n.* collection. Apart from the slight difference in the degree of horning, these two groups of Rye and Trudgen specimens appear very similar. The lack of clear morphological differences among Boorabbin specimens makes formal recognition of more than one taxon impracticable. Instead, subsp. *reliqua* is regarded as being variable both in its leaf length and sepal morphology in the eastern part of its range.

Also with relatively long leaves, but this time with more consistently longer leaves, is the Newbey specimen that was used as the basis for the name *B.* sp. Queen Victoria Rock (K.R. Newbey 6103). That specimen has particularly short (or more or less absent) pedicels 0–0.8 mm long, and peduncles 3–3.5 mm long. Similarly *B.* sp. Coolgardie (A. Strid 21320) is based on a specimen with consistently long leaves, but in this case it shows no obvious morphological distinctiveness in any characters from the remaining variants.

Three other names relevant to the eastern material are *B.* sp. Bulla Bulling (D.J.E. Whibley 4648), *B.* sp. Gnarlbine Rocks (G. Barrett GRH 469) and *B.* sp. Ubini (R. Pullen 9610), all with definite horns on the sepals, similar to sepals on some specimens of subsp. *cometes*. These specimens could be regarded as being intermediate between subspp. *reliqua* and *cometes* but are retained here within subsp. *reliqua* because they intergrade with specimens of the latter that occur nearby.

In the south of the range of the *H. ochropetala* complex, there are three groups of specimens, one group previously housed as *B.* sp. Roundtop Hill (P. Armstrong 05/843), a second group from further south at Taylor Rock with no phrase name attached, and the last group from furthest south now housed

under the phrase name *H.* sp. Exclamation Lake (M.E. Trudgen 1524). Exclamation Lake specimens have longer leaves than most other specimens and are being retained as a separate taxon at present, but the Roundtop Hill specimens are not so distinctive.

Notes. The petioles in subsp. *reliqua* are often very long in comparison with the length of the blade. Peduncles are usually ± smooth but prominently glandular ones are found in a few specimens e.g. *P. Armstrong* 05/840. Subspecies *cometes* tends to have a more prominently glandular hypanthium than subsp. *reliqua*.

Hysterobaeckea petraea Rye, *sp. nov.*

Typus: *c.* 1.5 km north of Koorda–Southern Cross Rd on Barbalin–Koonkoobing Rd, east of Bencubbin, Western Australia, 13 October 2004, *B.L. Rye* 241019 *& M.E. Trudgen* (*holo*: PERTH 07273835; *iso*: CANB, K, MEL, NSW).

Baeckea recurva Trudgen ms, in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 348 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Barbalin (B.L. Rye & M.E. Trudgen BLR 241022), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Pigeon Rocks (D. Grace DJP 281), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Illustrations. W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.* 3A: 78 (1980) [as *Baeckea behrii*]; drawings by R.J. Cranfield on *R.J. Cranfield & P.J. Spencer* 7696 and by C.A. Gardner on *W.E. Blackall* 3426.

Shrub 1–4 m high, up to 4 m across; flowering branchlets usually with 1–3 pairs of flowers, the leaves appressed to moderately spreading. *Petioles* 0.5–0.8 mm long. *Leaf blades* narrowly oblong in outline, 3–6(–8) mm long, 0.6–1 mm wide, 0.5–0.8 mm thick, with a recurved apical point; abaxial surface with 1 or 2 main rows of oil glands on each side of midvein, with a line-like or open groove; adaxial surface not grooved; apical point 0.8–2 mm long. *Peduncles* 1.5–3 mm long, normally 1-flowered. *Bracteoles* deciduous, 1.1–2.3 mm long, 0.4–0.8 mm wide. *Pedicels* 0–1(–1.7) mm long. *Flowers* 7–10 mm diam. *Hypanthium* 1.7–2 mm long, 2.7–3 mm wide; free portion up to *c.* 0.5 mm long. *Sepals* oblong-ovoid to depressed-elliptic or depressed-ovoid, 0.7–1.8 mm long, 2–2.5 mm wide, whitish, smooth or outermost one slightly ridged. *Petals* 2.5–4 mm long, white (possibly rarely pale pink). *Stamens* 12–18, in antisepalous groups of 2–4. *Longest filaments* 1–1.5 mm long. *Anthers* 0.4–0.5 mm wide from front view; connective gland *c.* 0.5 mm long; thecae 0.25–0.3 mm long. *Ovary* 3-locular; ovules 12–18 per loculus. *Style* 1.8–2.5 mm long; stigma 0.3–0.5 mm diam. *Fruits c.* 2/3 inferior, 2.5–3 mm long, 3–3.5 mm diam.; hypanthium smooth in distal 0.4–0.7 mm. *Seeds* 0.8–1.35 mm long, 0.45–0.6 mm wide, 0.6–0.7 mm thick, pale to medium brown; outer surface smooth. (Figure 8A)

Diagnostic characters. Distinguished from all but two species in having leaves with an abaxial rather than an adaxial groove, and distinguished from those two species by the following combination of characters: leaf blades usually 3–6 mm long, peduncles 1.5–3 mm long, pedicels absent or up to 1.7 mm long and petals 2.5–4 mm long.

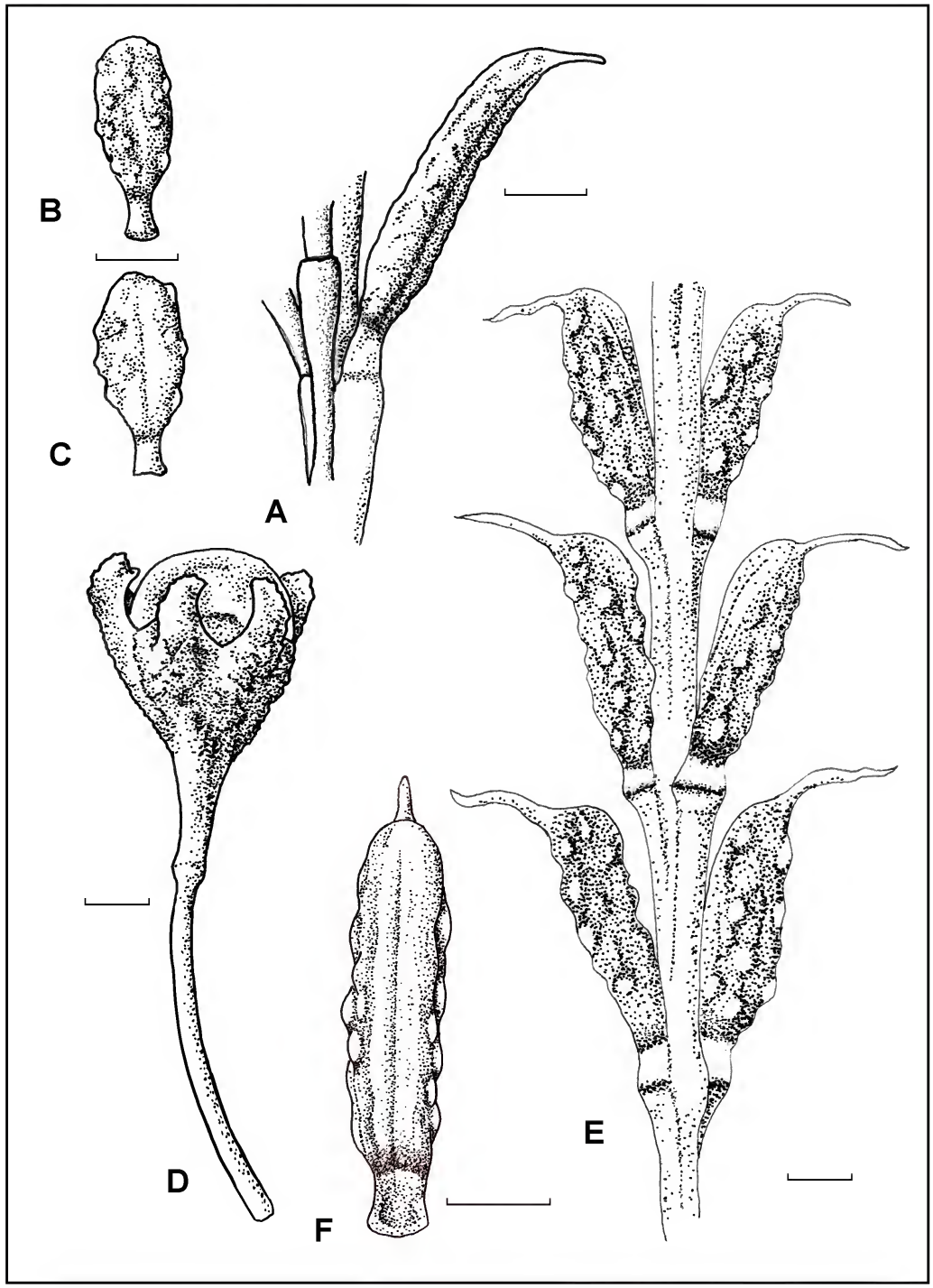

Figure 8. *Hysterobaeckea petraea*. A – leaf with abaxial groove. *Hysterobaeckea pterocera*. B – abaxial surface of leaf; C – adaxial surface of leaf, D – flower bud, pedicel and peduncle (bracteoles shed). *Hysterobaeckea setifera* subsp. *meridionalis*. E – opposite leaves; F – adaxial surface of leaf. Scale bars = 1 mm. Drawn by Skye Coffey from *B.L. Rye* 241019 & *M.E. Trudgen* (A), *M.E. Trudgen* 23414 A (B–D) and *B.L. Rye* 241049 & *M.E. Trudgen* (E, F).

Selected specimens examined. WESTERN AUSTRALIA: Mt Churchman, near summit, 19 Sep. 1985, *B.J. Conn* 2284 (PERTH); 58 km SW of Norseman, 20 Aug. 1995, *R.J. Cranfield* 10232 (PERTH); Sandford Rocks, near Westonia, 29 Sep. 2005, *M.D. Crisp* 10093 *& L.G. Cook* (PERTH); S of Coolgardie, 11 Oct. 1955, *E. Gauba s.n.* (CBG 024784); Yanneymooning Hill Nature Reserve, NE of Muckinbudin, 8 June 2008, *M. Hislop* 3775 (PERTH); Bonnie Rock–Wialki, 11 Sep. 1957, *A.R. Main s.n.* (PERTH); Pigeon Rocks, Diemals Stn, *c.* 10 km N of Windarling, 16 Mar. 2010, *S. Reiffer* SRE 022 (CANB, MEL, NSW, PERTH); 3.6 km S of Luckman Rd, 4.7 km N of Koorda–Southern Cross Rd on Barbalin–Koonkoobing Rd, E of Bencubbin, 13 Oct. 2004, *B.L. Rye* 241022 *& M.E. Trudgen* (BRI, PERTH); Chiddarcooping Hill Nature Reserve, *c.* 70 km NE of Merredin, 3 Nov. 1984, *A.S. Weston* 14451 (PERTH).

Distribution and habitat. Occurs from Mt Churchman and Bencubbin south-east to the Norseman area (Figure 6). One of the specimens was labelled with the doubtful locality of Wongan Hills (*P. Roberts* 237), but this record has been removed from the distribution data as it was probably collected at Karroun Hill or Giles Rock, where Roberts made a number of collections (e.g. *P. Roberts* 234) in September 1983. Through most of its range *H. petraea* appears to be restricted to granite outcrops, but at the south-eastern end of the range most of the specimens are from laterite rather than granite. *Baeckea* sp. Walyahmoning (M.E. Trudgen 5412), a species of uncertain generic placement, co-occurs with *H. petraea* on one granite outcrop but not in the same soil pockets. When specimens of both species were collected there on 14 October 2004, *H. petraea* (*B.L. Rye* 241043 & 241044 *& M.E. Trudgen*) was recorded from a large soil pocket near the base of the outcrop while *B.* sp. Walyamoning (*B.L. Rye* 241042 *& M.E. Trudgen*) was in a somewhat higher, small soil pocket.

Phenology. Flowers mainly from August to October.

Conservation status. This widespread taxon is not considered to be at risk. The phrase name *B.* sp. Pigeon Rocks (D. Grace DJP 281) is listed by Smith and Jones (2018) as Priority One, with no priority given to the other phrase name.

Chromosome number. $2n = c.$ 22 (Rye 1979: 571) [as *Baeckea grandiflora*]; voucher *B.L. Rye* 74003.

Etymology. From the Greek *petraios* (belonging to rocks) as this species is restricted to granite and lateritic outcrops.

Affinities. Two other species are currently recognised in the *H. petraea* group, *H. graniticola* (which is very similar; see notes under that species) and *H.* sp. Mt Zeil. *Hysterobaeckea petraea* tends to have shorter leaves and peduncles than both of those taxa, with *H. graniticola* having larger flowers (with petals 4–5 mm long) and *H.* sp. Mt Zeil having fewer ovules (5–9 per loculus).

Variation. Hysterobaeckea petraea comprises isolated populations occurring on rock outcrops scattered over a large area. Short-leaved specimens are widespread but with the shortest, thickest leaves tending to be in the Coolgardie–Norseman area where specimens also tend to have relatively long pedicels. Specimens with thinner, medium-length leaves occur in the Sinclair Soak area, east of Norseman.

The variant previously known as *Baeckea* sp. Pigeon Rocks occurs on the inland, north-eastern edge of the geographical range but is not particularly distinctive. One specimen (*V. Clarke* 573) from Pigeon Rocks has unusually long, narrow leaves, with a blade up to 8 mm long rather than 3–6 mm long as in all other specimens from that locality; these atypical leaves were apparently derived from a flush

of new growth. Another abnormality is a two-flowered peduncle observed on a specimen (*S. Reiffer* SRE 022) from this locality.

Notes. *Hysterobaeckea petraea* was sampled for a molecular study (Lam *et al.* 2002) using the voucher specimen *P.G. Wilson & N. Lam* PGW 1388. It appears on average to be the largest member of the genus, with a maximum height of 4 m and girth of 200 mm recorded.

Hysterobaeckea pterocera Rye, *sp. nov*.

Typus: south-east of North Ironcap, Western Australia [precise locality withheld for conservation reasons], 12 December 2008, *M.E. Trudgen* 23414A (*holo*: PERTH 08228310; *iso*: CANB, K, MEL).

Baeckea sp. Flying Fox Mine (A. O'Connor & V. Longman FF532), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Shrub commonly 0.4–0.8 m high, width not recorded; flowering branchlets with usually 1 or 2 pairs of flowers, the leaves appressed to moderately spreading. *Petioles* 0.5–0.6 mm long. *Leaf blades* oblong-elliptic or broadly so in outline, 1.5–2.2 mm long, 0.8–1.3 mm wide, 0.7–1 mm thick, not or scarcely mucronate; abaxial surface with prominent oil glands in 2 or 3 main rows on each side of midvein; adaxial surface lacking a furrow or with one poorly developed in the basal half of blade. *Peduncles* 5–12 mm long, 1-flowered. *Bracteoles* deciduous, 0.6–1.5 mm long, *c.* 0.3 mm wide, scarious. *Pedicels* 0.5–3.5 mm long. *Flowers* 9–11 mm diam. *Hypanthium* 2.7–3 mm long, 3.5–4 mm wide; free portion 0.5–1 mm long. *Sepals* ± depressed-ovate-triangular, 0.9–1.5 mm long, 1.5–2.2 mm wide at base (but much narrower above); horn projecting dorsally more than distally, bilaterally compressed and somewhat wing-like, 0.7–1.3 mm long. *Petals* 3–3.5 mm long, white. *Stamens* 19–23, in a circle. *Longest filaments* 0.9–1.5 mm long, *c.* 0.3 mm wide at base. *Anthers* 0.4–0.6 mm wide from front view; connective gland *c.* 0.5 mm long; thecae *c.* 0.3 mm long. *Ovary* 3-locular; ovules 9–13 per loculus. *Style* 1.6–2.8 mm long; stigma 0.4–0.5 mm diam. *Fruits c.* half-inferior, *c.* 4 mm long, *c.* 4 mm wide excluding calyx and 6–7 mm wide including calyx; hypanthium smooth in distal *c.* 0.6 mm. *Seeds* 0.8–1.3 mm long, 0.5–0.6 mm wide, 0.6–0.7 mm thick, yellowish brown; outer surface smooth. (Figures 8B–D, 9)

Diagnostic characters. This species is distinctive in having sepals with a laterally projecting, wing-like horn; other members of the genus either lack a horn or have it poorly developed to distally projecting. Other important characters: leaves 1.5–2.2 mm long, not or scarcely pointed, with adaxial groove absent or only partially developed; ovules 9–13 per loculus.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 27 July 2005, *P.G. Armstrong* PA 05/258 (PERTH); 21 June 2005, *G.F. Craig* 6534 (AD, NSW, PERTH); 22 Mar. 2004, *A. O'Connor & V. Longman* FF 532 (BRI, DNA, PERTH).

Distribution and habitat. Known from the Forrestania area, east of Hyden (Figure 5). Recorded on a low stony ridge and in sandplain sites with brown sand with some gravel. *Hysterobaeckea pterocera* has been recorded growing with *Baeckea muricata* C.A.Gardner and *B.* sp. North Ironcap (R.J. Cranfield 10580).

Phenology. Flowers recorded in June and December and mature fruits in March.

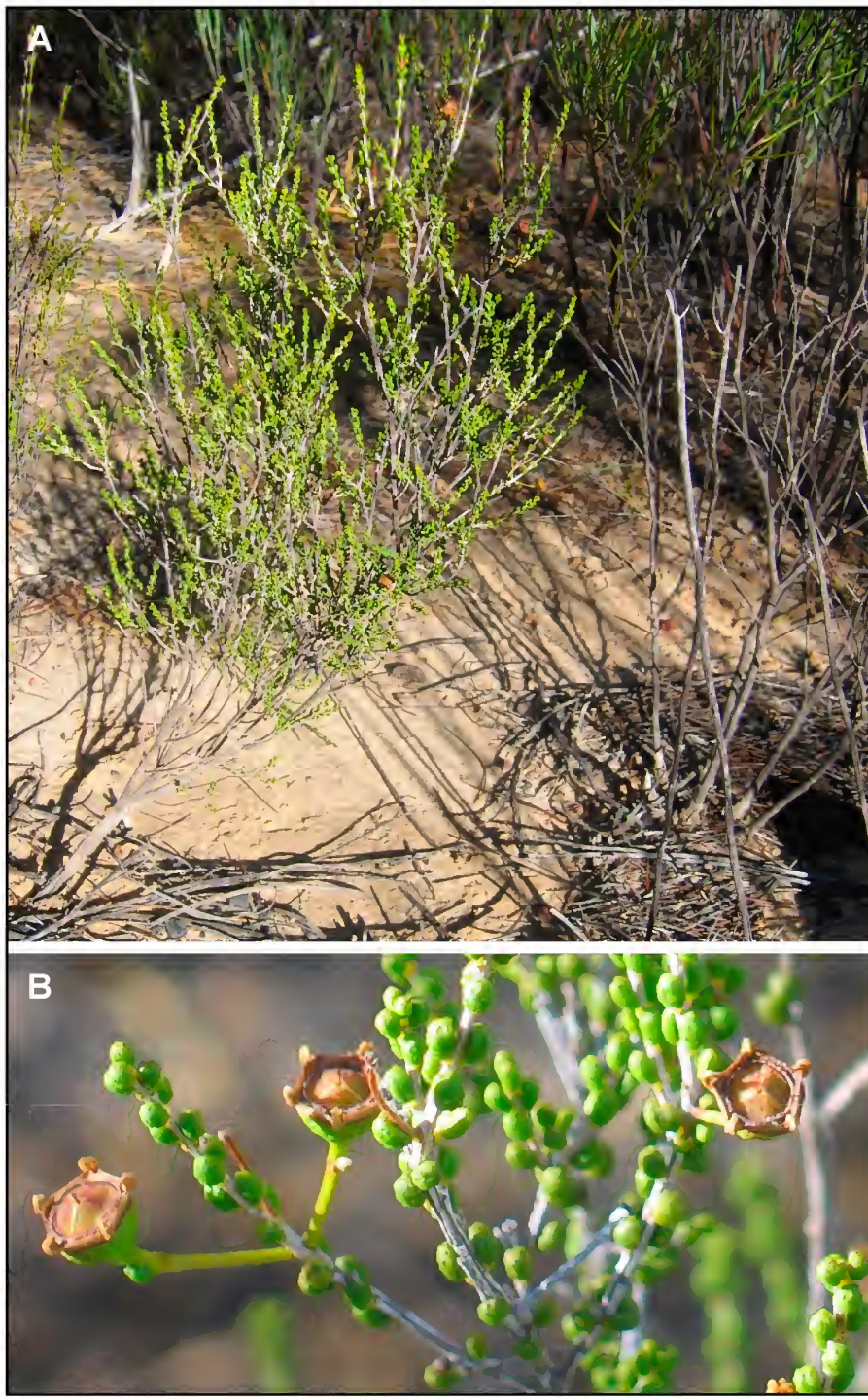

Figure 9. *Hysterobaeckea pterocera*. A – single-stemmed, erect plant; B – fruiting branchlets. Images taken by Alice O'Connor at the population where the *A. O'Connor & V. Longman* FF 532 specimen was collected.

Conservation status. Recently listed as Priority One under Conservation Codes for Western Australian Flora under the phrase name *Baeckea* sp. Flying Fox Mine (A. O'Connor & V. Longman FF532). This geographically restricted species is currently known from three collection sites, which extend for a distance of *c.* 6 km.

Etymology. From the Greek *ptero-* (winged) and *-ceras* (-horn, horn-like projection) referring to the wing-like flattened shape of the very prominent dorsal ridge on each sepal.

Affinities. Similar to *H. ochropetala*, but that species has the adaxial furrow better developed on the leaf and more numerous ovules. The peduncles in *H. pterocera* are often prominently glandular as in *H. glandulosa*.

Notes. Flower buds and fruits are crowned by five, wing-like horns formed by the calyx (Figure 8B). After the flowers open, each wing is lateral to the sepal body rather than projecting distally above it as in *H. cornuta* and *H. ochropetala* subsp. *cometes* (see Figure 7D).

Hysterobaeckea setifera Rye, *sp. nov.*

Typus: 4.9 km north of Wanarra Rd, on Rabbit Proof Fence Rd, east of Perenjori, Western Australia, 13 October 2003, *B.L. Rye* 231020 *& M.E. Trudgen* (*holo*: PERTH 06588441; *iso*: CANB, K, MEL, NSW).

Illustration. Drawings on *C.A. Gardner s.n.* Sep. 1939 (PERTH 03351777).

Shrub 0.9–3.2 m high, 0.5–3 m wide; flowering stems usually with 1–3 pairs or clusters of flowers, the leaves appressed or almost so. *Petioles* 0.2–1 mm long. *Leaf blades* oblong to linear in outline, (2–)3–9 mm long, 0.8–1.3 mm wide, 0.7–1 mm thick, apex obtuse with a recurved point; abaxial surface with 2 or 3 main rows of prominent or very prominent oil glands on each side of midvein; adaxial surface with a line-like furrow extending its full length; apical point 0.7–2.4 mm long, usually bent ± at right angles to the midvein. *Peduncles* (3–)5–15 mm long, 1(–3)-flowered; secondary axes (when present) 2–4 mm long. *Bracteoles* deciduous or persistent in young fruit, 1.5–3.3 mm long, 0.2–1 mm wide. *Pedicels* usually 0.8–3(–4) mm long, rarely indistinct or apparently absent. *Flowers* 9–14 mm diam. *Hypanthium* 1.8–3 mm long, 3–5 mm wide; free portion 0.6–1 mm long. *Sepals* very reduced (low and rounded) to almost triangular, 0.3–1.3 mm long, 1.5–2.5 mm wide, erect, often reddish, scarious margin ± absent to almost the whole lobe, the herbaceous part glandular, sometimes ridged on outer sepals. *Petals* 3–5 mm long, white. *Stamens* 17–26, in a circle. *Longest filament*s 0.8–1.3 mm long, 0.1–0.35 mm wide at base. *Anthers* 0.4–0.5 mm wide from front view; connective gland 0.4–0.7 mm long; thecae 0.3–0.4 mm long. *Ovary* 3-locular; ovules 10–18 per loculus. *Style* 2.3–3 mm long; stigma 0.4–0.5 mm diam. *Fruits* 3.5–5 mm long, 4–6 mm wide excluding calyx and the same or up to 7 mm wide including calyx; hypanthium smooth in distal 0.5–1.1 mm. *Seeds* 1–1.5 mm long, 0.4–0.9 mm wide, 0.7–1 mm thick, whitish to orange-brown or pale speckled brown; outer surface smooth.

Diagnostic characters. Among the species that have leaves with an obvious apical point (0.7–2.4 mm long in this case), *H. setifera* is distinguished by the following combination of characters: appressed leaves with a line-like adaxial groove, sepals very reduced to ± triangular and seeds with outer surface smooth.

Distribution and habitat. Extends almost 500 km from Pindar south-east to near Narembeen (Figure 5), occurring in varied habitats with sandy soils, for example in yellow sand and yellow brown sandy loam, at least sometimes associated with laterite.

Conservation status. Not considered to be at risk.

Phenology. Flowers recorded mainly from September to November, with mature fruits recorded from October onwards.

Etymology. The epithet, based on the Latin word *setifer* (bristle-bearing), refers to the stems. Since each of the appressed leaves terminates in a long, bristle-like point (see Figure 8E), the stems appear bristly.

Affinities. While its closest affinities are uncertain, *H. setifera* is most likely to be confused with *H. longipes*; see notes under that species.

Notes. Two main variants, treated here as subspecies, have been recognised previously by having separate phrase names, with *B.* sp. Bencubbin-Koorda (M.E. Trudgen 5421) having moderate-sized sepals and *B.* sp. Wanarra (M.E. Trudgen 5376) having reduced sepals. The former (subsp. *meridionalis* Rye) occupies the southern or south-eastern half of their combined range and the latter (subsp. *setifera*) occurs in the remainder of the range, while a few specimens from near the centre of the combined range (see Figure 6) are somewhat intermediate in sepal morphology.

The first published name of this new species, *Baeckea behrii* var. *brevifolia nom. nud.*, distinguished the southern subspecies of *H. setifera* from the eastern Australian *H. behrii s. str.* by its shorter leaves. However, there are several Western Australian members of the genus with even shorter leaves, such as *H. cornuta*.

Most specimens of *H. setifera* have all peduncles 1-flowered. Even on specimens with up to three flowers per peduncle, most of the peduncles are 1-flowered.

Hysterobaeckea setifera subsp. **meridionalis** Rye, *subsp. nov.*

Typus: south of Warrachuppin on Warrachuppin Rd, *c.* 5.7 km north of George Rd and *c.* 4 km south of Daddow Rd, Western Australia, 14 October 2004, *B.L. Rye* 241049 *& M.E. Trudgen* (*holo*: PERTH 07264410; *iso*: CANB, K, MEL, NSW).

Baeckea behrii var. *brevifolia* F.Muell. *nom. nud.*, *J. Bot.* 15: 280 (1877). *Type*: near Mt Churchman, Western Australia, 1875, *J. Young s.n.* (MEL 72515).

Baeckea benthamii Trudgen ms, in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat* p. 346 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Bencubbin–Koorda (M.E. Trudgen 5421), in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 348 (2000), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Baeckea sp. Lake Campion (A. Coates AC 2285), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Leaf blades oblong to linear in outline, (2–)3–6 mm long; apical point 0.7–1.7 mm long. *Sepals* reduced and rounded to almost triangular, 0.5–1.3 mm long, scarious margin broad, sometimes almost the whole lobe scarious, broadly obtuse to acute. (Figure 8E, F)

Diagnostic characters. Differs from subsp. *setifera* mainly in having larger sepals. It usually also has a shorter apical point on its leaves.

Selected specimens examined. WESTERN AUSTRALIA: 13 miles [21 km] N of Bencubbin, 6 Oct. 1937, *W.E. Blackall* 3307 (PERTH); between Koorda and Mollerin, Sep. 1939, *C.A. Gardner s.n.* (PERTH); Wyalcatchem, Oct. 1959, *B.J. Grieve s.n.* (PERTH); 5.8 km W of Koorda along dirt road to Manmanning, 8 Oct. 1991, *R.W. Greuter* 22630 (PERTH); Cowcowing, Aug.–Sep. 1904, *M. Koch* 1230 (MEL, NSW, PERTH); no. 5 Pumping Station, Yerbillon, 26 Oct. 1923, *M. Koch* 2909 (MEL); 5 miles [8 km] E of Trayning, 22 Oct. 1964, *K.R. Newbey* 1686 (PERTH); W of Mt Jackson/Diemal Stn, 16 Nov. 1993, *H. Pringle* 30110 (PERTH); turnoff to Remlap Stn homestead from Mouroubra Rd, 16 Sep. 2012, *K.R. Thiele & S.M. Prober* KRT 4669 (PERTH); *c.* 1 mile [1.6 km] W of Bonnie Rock Siding near N end of Dotanning Rd, 14 Oct. 1986, *M.E. Trudgen* 5421 (PERTH); 2 miles [3 km] S of Carrabin, 19 Nov. 1986, *M.E. Trudgen* 5441 (CANB, K, MEL, NSW, PERTH); near Mt Churchman, 1875, *J. Young s.n.* (MEL).

Distribution and habitat. Extends from Remlap Station south-east to near Narembeen, with an outlying collection inland at Diemals Station (Figure 5). The southernmost record of 'near Narembeen' (*W.E. Blackall s.n.* Sep. 1929, PERTH 04138848), mapped as Narembeen on the figure, is also somewhat isolated so may have been collected to the north of Narembeen.

Conservation status. Not considered to be at risk, this subspecies has a distribution more than 200 km long, and is known from several reserves.

Etymology. From the Latin *meridionalis* (southern), alluding to the southern distribution of this subspecies.

Variation. A single short-leaved, non-flowering specimen, with leaves *c.* 2 mm long, has been known as *B.* sp. Lake Campion (A. Coates AC 2285). Some other specimens, e.g. *B.L. Rye & M.E. Trudgen* BLR 241038, have some dormant branchlets with similarly small leaves, although their growing branchlets have much longer leaves. As *A. Coates* AC 2285 was collected in April, its branchlets all appear to be dormant, which could explain its consistently short leaves. More collections are needed to determine the leaf size on flowering specimens from this locality. The specimen may also be affected by its occurrence in an atypically saline habitat, as it was collected from a large lunette dune near a salt lake.

Some specimens from the Mollerin–Beacon area, such as *C.A. Gardner s.n.* Sep. 1939 (PERTH 03351777), appear to be intermediate between the two subspecies and are mapped with a distinct symbol in Figure 5.

Notes. Subspecies *setifera* tends to have longer leaves than subsp. *meridionalis*, although there is considerable overlap in leaf size between them. The leaf apical point length shows less overlap, as

does sepal length.

Hysterobaeckea setifera Rye subsp. **setifera**

Baeckea sp. Wanarra (M.E. Trudgen 5376), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 10 May 2016].

Leaf blades narrowly oblong or linear in outline, 3.5–9 mm long; apical point 1.5–2.4 mm long. *Sepals* reduced or very reduced, usually rounded, 0.3–0.6 mm long, scarious margin ± absent or narrow throughout or with a protruding central area, rarely with an apical point up to 1 mm long.

Diagnostic characters. Differs from subsp. *meridionalis* mainly in having more reduced sepals. It usually also has a longer apical point on its leaves.

Selected specimens examined. WESTERN AUSTRALIA: *c.* 160 km E of Geraldton on the Yalgoo road, 1 Sep. 1968, *A.M. Ashby* 2582 (AD, PERTH); 7.5 km SSE of Rothsay Mine, 22 Nov. 1992, *R.J. Cranfield* 8594 (PERTH); Pindar, 200 m along Tardun road, 13 Oct. 1981, *L.A. Craven* 7111 (PERTH); *c.* 50 km directly NE of Perenjori at Old Karara Stn, 25 Oct. 1992, *A.M. Lyne* 883, *L.A. Craven & F. Zich* (PERTH); White Well Stn, *c.* 150 m N of homestead along track to Wanarra Rd, 7 Oct. 2003, *S.J. Patrick* 4858 (PERTH); 14 miles [23 km] E of Mt Gibbs Homestead turnoff from Paynes Find–Wubin Rd, 1 Sep. 1974, *B.L. Powell* 74078 (PERTH); 2.55 km S of NE corner of CALM reserve on Lochada Rd, E of Koolanooka, 10 Sep. 2003, *B.L. Rye* 239080 *& M.E. Trudgen* (PERTH); Glamoff Rd, 1.9 miles [3.1 km] W of Struggle Rd, SE of Wubin, 12 Nov. 1986, *M.E. Trudgen* 5402 (AD, BRI, PERTH).

Distribution. Extends from Pindar south to Pithara and south-east to Mt Gibson Sanctuary (Figure 5).

Conservation status. This subspecies is not considered to be at risk. It has a distribution more than 200 km long, and is known from several reserves including Charles Darwin Nature Reserve.

Chromosome number. n = 11 (Rye 1979: 570) [as *Baeckea* sp. *aff. behrii*], voucher specimen: *B.L. Powell* 74078.

Variation. The hyaline margin of the sepals ranges from more or less absent or very narrow and fairly uniform in most specimens to one that is distinctly larger at the centre and acute in a few specimens (e.g. *A.M. Ashby* 2582) or produced into a short to leaf-like apical point (e.g. *E. Wittwer* 1241).

Notes. This subspecies is notable for the long apical point on its leaves, similar in measurement to that of *H. longipes* but longer in proportion to the length of the leaf blade. Indeed it has the longest apical point, up to almost 2.5 mm, recorded for the tribe Chamelaucieae.

Acknowledgements

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and Steve Dillon assisted with the preparation of maps. I am also grateful to Peter Wilson for his advice and Alice O'Connor for the images.

References

Bean, A.R. (1997). Reinstatement of the genus *Babingtonia* Lindl. (Myrtaceae). *Austrobaileya* 4: 627–645.

Blackall, W.E. & Grieve, B.J. (1954). *How to know Western Australian wildflowers*. Part 1. (University of Western Australia Press: Nedlands.)

Blackall, W.E. & Grieve, B.J. (1980). *How to know Western Australian wildflowers*. Part 3A. Revised 2nd edn by B.J. Grieve. (University of Western Australia Press: Nedlands.)

Lam, N., Wilson, Peter G., Heslewood, M.M. & Quinn, C.J. (2002). A phylogenetic analysis of the *Chamelaucium* alliance (Myrtaceae). *Australian Systematic Botany* 15: 535–543.

Mueller, F. (1876). Myrtaceae. *In: Fragmenta phytographiae Australiae*. Vol. 10, pp. 22–31. (Government Printer: Melbourne.)

Mueller, F. (1877). List of the plants obtained during Mr. G. Giles's travels in Australia in 1875 and 1876. *The Journal of Botany* 15: 269–281.

Niedenzu, F. (1893). Myrtaceae. *In*: Engler, A. & Prantl, K. (eds) *Die natürlichen Pflanzenfamilien*. Vol. 3(7), pp. 57–105. (Engelmann: Liepzig.)

Paczkowska, G. & Chapman, A.R. (2000). *The Western Australian Flora: a Descriptive Catalogue*. (Wildflower Society of Western Australia: Nedlands, Western Australia.)

Rye, B.L. (1979). Chromosome number variation in the Myrtaceae and its taxonomic implications. *Australian Journal of Botany* 27: 547–573.

Rye, B.L. (2013a). A revision of the south-western Australian genus *Astartea* (Myrtaceae: Chamelaucieae). *Nuytsia* 23: 189–269.

Rye, B.L. (2013b). An update to the taxonomy of some Western Australian genera of Myrtaceae tribe Chamelaucieae. 1. *Calytrix*. *Nuytsia* 23: 483–501.

Rye, B.L. (2015a). Recognition of *Hysterobaeckea* as a genus of Myrtaceae tribe Chamelaucieae. *Nuytsia* 25: 209–218.

Rye, B.L. (2015b). A revision of the south-western Australian genus *Babingtonia* (Myrtaceae: Chamelaucieae). *Nuytsia* 25: 219–250.

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 30 January 2018].

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Eucalyptus revelata, a rare new species related to *E. mooreana* (Myrtaceae) from the Kimberley region of Western Australia

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Abstract

Nicolle, D. & Barrett, R.L. *Eucalyptus revelata*, a rare new species related to *E. mooreana* (Myrtaceae) from the Kimberley region of Western Australia. *Nuytsia* 29: 109–118 (2018). Two variants of *E. mooreana* W.Fitzg. *s. lat.*, a rare species from the Kimberley region of Western Australia, are found to be specifically distinct. A revised description of *E. mooreana* is provided and *E. revelata* D.Nicolle & R.L.Barrett is described to accommodate plants with a more sprawling habit, less powdery and less uniformly-coloured bark, non- or weakly-pruinose features, green leaves and generally smaller fruits. Both *E. mooreana* and *E. revelata* are restricted to steep rocky slopes and mountain ridges in the higher parts of the King Leopold Ranges. A key to the terminal taxa of *Eucalyptus* ser. *Subexsertae* (Benth.) Blakely (the 'northern white gums') is provided. Authorship of the name *E. mooreana* is discussed and attributed to W.V. Fitzgerald rather than J.H. Maiden. A new lectotype is designated as the previous designation was found to be ineffective.

Introduction

Eucalyptus mooreana W.Fitzg. is restricted to the King Leopold Ranges in the Kimberley region of northern Western Australia. Two morphological variants of *E. mooreana* have long been recognised, with herbarium specimens of the species annotated as either a glaucous (typical) variant or a non-glaucous variant by L.A.S. Johnson in the National Herbarium of New South Wales (NSW) and by C.R. Dunlop in the Northern Territory Herbarium (DNA). However, the occurrence of *E. mooreana* on steep rocky terrain in a remote and relatively inaccessible region has limited investigation of these variants. All previous publications including *E. mooreana* (e.g. Gardner 1979; Chippendale 1988; Rye 1992; Brooker & Kleinig 1994, 2004; Slee *et al.* 2006) have also included the non-glaucous variant as a minor part, and several illustrate this variant as *E. mooreana*. A recent survey of the King Leopold Ranges Conservation Park by Western Australia's Department of Biodiversity,

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Conservation and Attractions (formerly the Department of Parks and Wildlife) has resulted in many new collections and an enhanced understanding of the two variants, to the extent that we are now confident that they represent different species. The two species are distinctive both in the field and in herbaria, most notably in the type variant of *E. mooreana* having greyish, pruinose leaves and the other variant, described here as *E. revelata* D.Nicolle & R.L.Barrett, having green, non-pruinose leaves.

Eucalyptus mooreana and *E. revelata* are part of *E.* subg. *Symphyomyrtus* (Schauer) Brooker sect. *Exsertaria* L.D.Pryor & L.A.S.Johnson ex Brooker ser. *Subexsertae* (Benth.) Blakely (following Brooker 2000), a series of 17 terminal taxa (including several undescribed taxa) collectively known as the 'northern white gums'. The series is restricted to northern Australia and adjacent islands to the north, including New Guinea and some of the Lesser Sunda Islands. It is distinguished by the combination of its resprouter regenerative strategy (Nicolle 2006), reniform cotyledons, smooth, relatively uniformly-coloured, often powdery, seasonally-decorticating bark, apparently glandless branchlet pith, concolorous leaves with dense to very dense tertiary venation and scattered or no visible oil glands (Brooker & Nicolle 2013), axillary, unbranched inflorescences, versatile, dorsifixed anthers, ovules in six or eight vertical rows, more-or-less annular fruit disc, and tooth-edged seeds.

Both species occur in remote, relatively inaccessible, and quite poorly botanically surveyed areas, and are long-lived, large, woody plants with presumed annual flowering cycles. As such, field collections of these two species are unlikely to represent any real threat to their conservation.

Key to the terminal taxa of *Eucalyptus* series *Subexsertae*

1. Mature crown mostly or entirely composed of opposite, sessile, juvenile leaves

2. Crown leaves not connate; well-formed tree of floodplains

3. All crown leaves sessile and pruinose ..... **E. apodophylla** subsp. **apodophylla**

3: Some crown leaves shortly petiolate and non-pruinose ..... **E. apodophylla** subsp. **provecta**[1]

2: Crown leaves mostly connate; poorly-formed tree or mallee of rocky hills

4. Crown leaves greyish, strongly pruinose ..... **E. mooreana**

4: Crown leaves green, not pruinose ..... **E. revelata**

1: Mature crown mostly or entirely composed of non-opposite, petiolate, adult leaves

5. All adult leaves orbicular to deltoid

6. Umbellasters mostly 3-flowered; fruits 15–24 mm wide ..... **E. pantoleuca**

6: Umbellasters mostly 7-flowered; fruits 5–10 mm wide

[1]*Eucalyptus apodophylla* subsp. *provecta* Brooker & Kleinig (Brooker & Kleinig 1994) occurs over a 50 km range on Doongan and Theda Stations in the Kimberley region of WA, and may be of hybrid origin (typical *E. apodophylla* Blakely & Jacobs ex Blakely × *E. bigalerita* F.Muell.). Slee *et al.* (2006) consider the subspecies to be synonymous with typical *E. apodophylla*. Further research is required to ascertain the status of subsp. *provecta*.

7. Fruits mostly <6 mm diam..... **E. tintinnans**

7: Fruits mostly >6 mm diam.

8. Adult leaves glossy, green.....**E. bigalerita**

8: Adult leaves dull, green to blue-green to greyish

9. Seedling and adult leaves not pruinose..... **E. platyphylla**

9: Seedling leaves pruinose; adult leaves pruinose or not

10. Adult leaves deltoid, pruinose or not (south-eastern New Guinea) ..... **E.** sp. **Port Morseby**[2]

10: Adult leaves orbicular, pruinose (Arnhem Land, NT) ..... **E.** sp. **Arnhem Land**[3]

5: Adult leaves mostly lanceolate to ovate or elliptic

11. Buds globular; seeds flattened-ovoid, hilum ± ventral; well-formed tree of floodplains and creeks

12. Buds and fruits sessile..... **E. houseana**

12: Buds and fruits pedicellate

13. Adult leaves mostly lanceolate.....**E. alba** var. **australasica**

13: Adult leaves broad-lanceolate to ovate or elliptic

14. Buds often pruinose (Lesser Sunda Islands).....**E. alba** var. **alba**

14: Buds not pruinose (northern Australia and adjacent islands) ..... **E.** sp. **Melville Island**[4]

11: Buds ovoid; seeds pyramidal, hilum ± terminal; poorly-formed tree of rocky hills

15. Adult leaves glossy, green ..... **E. glomericassis**

15: Adult leaves dull, green to blue-green

16. Umbellasters mostly 3-flowered; peduncles mostly <5 mm long..... **E. gregoriensis**

16: Umbellasters mostly 7-flowered; peduncles mostly >5 mm long

17. Fruits 7–12 mm diam., often pruinose..... **E. cupularis**

17: Fruits 4–6 mm diam., not pruinose..... **E. herbertiana**

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[2]*Eucalyptus* sp. Port Moresby (P. Darbyshire 601) has been nominated as the phrase name for northern white gums related to *E. platyphylla* F.Muell. from the Central Province of Papua New Guinea (Nicolle 2015). Representative specimen: Kairuku Subdistrict, Kanosia plantation, Papua New Guinea, 4 July 1962, *P. Darbyshire* 601 (CANB, K, L, NSW).

[3]*Eucalyptus* sp. Arnhem Land (K.D. Hill 3984 & L.C.Stanberg) has been nominated as the phrase name for northern white gums related to *E. platyphylla* from parts of Arnhem Land and Kakadu National Park in the NT (Nicolle 2015). Representative specimen: 152.9 km from Murganella road on Maningrida road, Northern Territory, 31 Aug. 1991, *K.D. Hill* 3984 *& L.C. Stanberg* (BRI, CANB, DNA, NSW).

[4]*Eucalyptus* sp. Melville Island (K.D. Hill 907, L.A.S. Johnson & D. Benson) has been nominated as the phrase name for northern white gums related to *E. alba* Reinw. ex Blume from the far north coast and adjacent islands of WA and the NT (Nicolle 2015). Representative specimen: S of Pickataramoor on road to Poonalie Beach, Melville Island, Northern Territory, 17 July 1984, *K.D. Hill* 907, *L.A.S. Johnson & D. Benson* (BRI, CANB, DNA, NSW, PERTH).

Taxonomy

Eucalyptus mooreana W.Fitzg., *The Western Mail* (*Perth*) 21(1066); 10, pl. p. 25 (2 June 1906). *Eucalyptus mooreana* W.Fitzg. ex Maiden, *J. & Proc. Roy. Soc. New South Wales* 47: 221–223 (1914). *Lectotype*: summit of Mt Rason [Mt Hart], King Leopold Range, Western Australia, [4] September 1905, *W.V. Fitzgerald* 1472 (*lecto*: NSW 41842, here designated; *isolecto*: BISH 1003629 image!, BM 001015293 image!, CANB 408833[5], K 000279811 image!, PERTH 01006991, PERTH 01007009, PERTH 01007017, PERTH 01007025, US 00409814 image!). *Residual syntypes*: summit of Mt Broome, Western Australia, [20] May 1905, *W.V. Fitzgerald* 830, *p.p.* (*syn*: PERTH 01052845); summit of Mt Leake, Western Australia, [3] July 1905, *W.V. Fitzgerald* 1202 (*syn*: NSW 304187, PERTH 01281178). *Excluded syntype*: summit of Mt Broome, Western Australia, [20] May 1905, *W.V. Fitzgerald* 830, *p.p.* (*syn*: NSW 304186) = *Eucalyptus revelata* D.Nicolle & R.L.Barrett.

Illustrations. J.H. Maiden, *Crit. Revis. Eucalyptus* 5: pl. 179, Figure 1A–E (1920); C.A. Gardner, *Eucalypts West. Austral.* p. 134, Figure 48 (1979); G. Chippendale, *Fl. Austral.* 19: 322, Figure 90K (1988); S.D. Hopper *et al.*, *West. Austral. Endangered Fl.* p. 62, Figure 142 (1990); B.L. Rye in J.R. Wheeler (ed.) *Fl. Kimberley Region* p. 521, Figure 156K (1992); M.I.H. Brooker & D.A. Kleinig, *Field Guide to Eucalypts Vol. 3. Northern Australia*, 1st edn & 2nd edn, p. 242 all images (1994, 2004); Slee *et al.*, *EUCLID Eucalypts of Australia* CD ROM, *Eucalyptus mooreana* upper left image only (2006).

Poorly-formed tree or *obligate mallee*, 1–6 m tall; lignotuber present (combination resprouter of Nicolle 2006). *Bark* smooth throughout, decorticating annually, powdery, white to slightly salmon pink. *Branchlets* pruinose, lacking pith glands. *Cotyledons* reniform. *Seedling leaves* opposite, petiolate, narrowly ovate, glabrous, dull, green, not pruinose. *Mature crown* composed entirely of juvenile leaves. *Juvenile leaves* opposite, sessile, ovate to broad-lanceolate, 45–140 mm long, 38–92 mm wide, concolorous, dull, greyish, strongly pruinose (at least when young); tertiary venation very dense; oil glands numerous, unconnected to vein network (island oil glands). *Inflorescences* held erect, 7–9-flowered; peduncles angular in T.S., stout, 7–18 mm long; pedicels ± absent. *Flower buds* diamond-shaped, pruinose, 10–14 mm long, 5–7 mm diam.; hypanthium slightly angular; operculum smooth, ± hemispherical to very slightly beaked. *Flowers* white, staminal filaments irregularly-flexed in bud; ovules in 6 vertical rows on each placenta. *Fruits* cupular, smooth, usually pruinose (at least when young), 6–9 mm long, 7–11 mm diam.; disc ± level; valves 4, strongly exserted above the rim. *Seeds* dark brown to black, obliquely pyramidal to elongate, 1–2 mm long. (Figure 1)

Diagnostic characters. *Eucalyptus mooreana* is distinguished within *Eucalyptus* ser. *Subexsertae* by its poorly-formed tree or mallee habit, its pruinose branchlets, its mature crown of opposite, sessile, often connate, pruinose juvenile leaves, its 7–9-flowered inflorescences, and its hemispherical to very slightly beaked opercula. Characters distinguishing it from *E. revelata* are its generally more upright or tree-like habit, its consistently powdery, uniformly white bark, its strongly pruinose branchlets, buds and fruits, its greyish, pruinose leaves, and its generally larger, 4-valved fruits.

Specimens examined. WESTERN AUSTRALIA: [localities obfuscated for conservation reasons] King Leopold Range, 29 Oct. 1982, *M.I.H. Brooker* 7756 (CANB, NSW, PERTH); Gibb River Rd, 12 Dec. 2009, *P. Docherty* 114 (BRO., PERTH); between Mt Vincent and Mt Chalmers, 26 May 2012, *P. Docherty* 291 (BRO., PERTH); 9 Sep. 1980, *C.C. Done* 310 (CANB); Lady Forrest Range,

[5]The CANB specimen is labelled 'August 1905, *W.V. Fitzgerald* 287', however both the date and collection number must be in error. Examination of a typescript of Fitzgerald's expedition diary (Fitzgerald 1905) shows that Mt Rason was visited twice, first on 28 July 1905 [specimen numbers 1281–1284], and secondly on 4 September [specimen numbers 1471–1474].

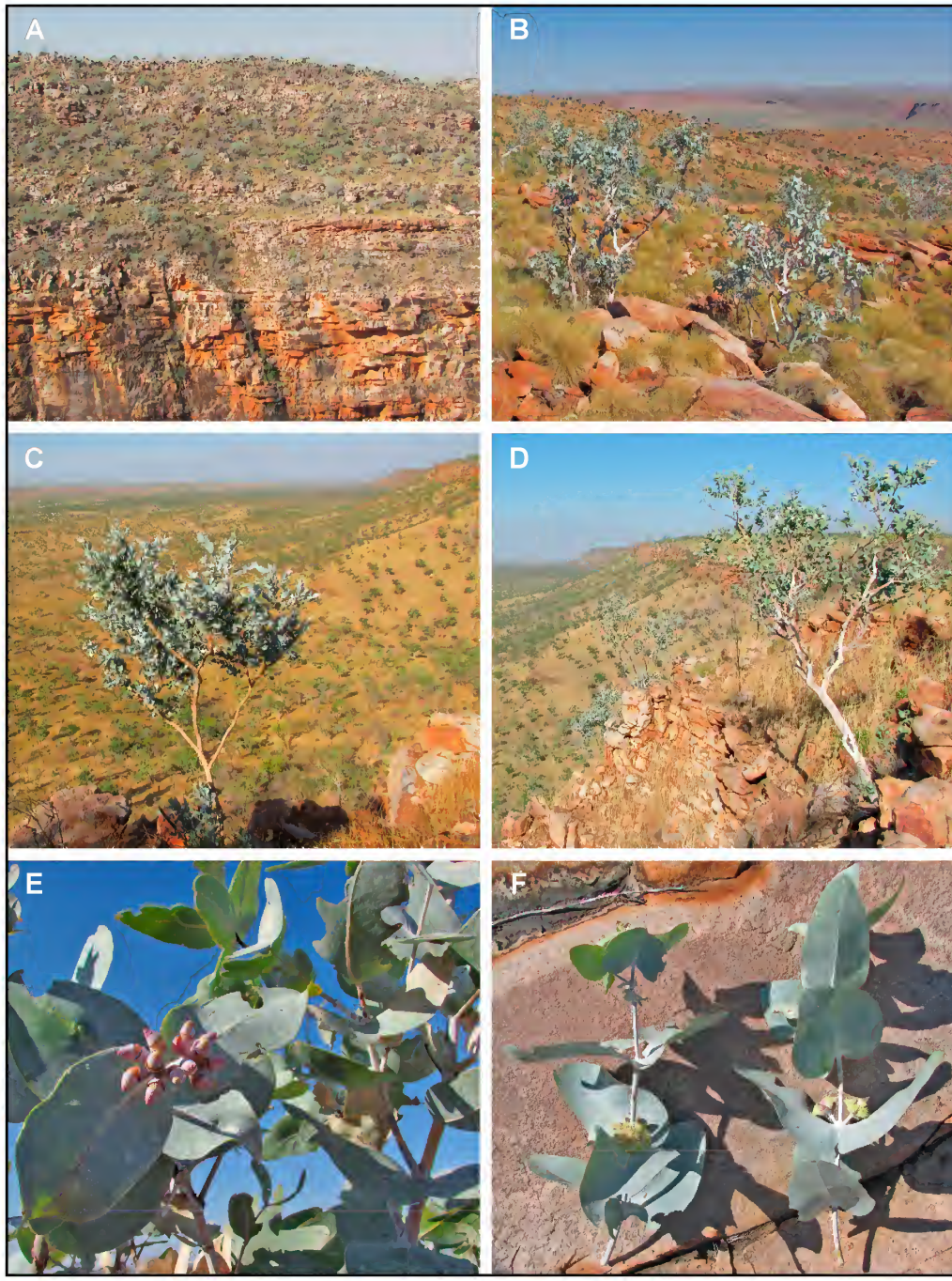

Figure 1. *Eucalyptus mooreana*. A – habitat on south-facing cliff on Mt Vincent; B – habitat and habit on Bold Bluff; C – habit of plant near Rifle Point; D – habit of plant at Precipice Range (note the more erect habit (compared to *E. revelata*) at all sites); E – crown foliage and flower buds; F – crown foliage and flowers. Photographs by Tim Willing.

7 Nov. 1986, *C.C. Done* 748 (PERTH); King Leopold Range, Apr. 1921, *C.A. Gardner* 578 (PERTH); Mt Bell, 30 July 1984, *K. Hill* 973, *L. Johnson & D. Benson* (NSW); King Leopold Ranges, 4 June 2006, *T. Sinclair & T. Willing* 1 (PERTH); King Leopold Ranges, 5 June 2006, *T. Sinclair & T. Willing* 3 (PERTH); Mt Ord, 5 June 2006, *T. Sinclair & T. Willing* 4 (CANB, PERTH); Lady Forrest Range, 5 June 2006, *T. Sinclair & T. Willing* 5 (CANB, PERTH); Mt Leake, 23 Sep. 2014, *T. Sonneman & T. Willing* 8 (PERTH); King Leopold Range Conservation Park, 23 Sep. 2014, *T. Sonneman & T. Willing* 10 (PERTH); Mt Ord, 24 Sep. 2014, *T. Sonneman & T. Willing* 13 (PERTH); Lady Forrest Range, 24 Sep. 2014, *T. Sonneman & T. Willing* 17 (PERTH); Mt Herbert, 24 Sep. 2014, *T. Sonneman & T. Willing* 19 (PERTH); Mt Vincent, 24 Sep. 2014, *T. Sonneman & T. Willing* 21 (PERTH); Gibb River Rd, 5 Sep. 2006, *L.S.J. Sweedman* 7000 (KPBG, PERTH); Mt Leake, 10 Aug. 1991, *T. Willing* 471 (DNA, PERTH).

Distribution and habitat. Restricted to the western part of the King Leopold Ranges (west of the Fitzroy River) in the Kimberley region of Western Australia. The species has been collected from a number of mountains and ridges, from Mt Hart in the north-west to Mt Leake in the south-east, over a linear range of about 130 km. It grows on the steep rocky slopes, ridges and summits of the higher sandstone hills and mountains in the ranges, and is also likely to occur on other ridges of similar altitude within this range. Some populations occur on lower-altitude rocky ridges (e.g. Lady Forrest Range) but are still relatively high in the landscape. Within populations, the plants are scattered in very open low woodland with *Corymbia collina*, *Eucalyptus lirata* and *E. phoenicea*, and with a *Triodia* ground storey.

Conservation status. *Eucalyptus mooreana* has been considered a rare species for several decades (Hopper *et al.* 1990; Briggs & Leigh 1996; Brown *et al.* 1998; Smith 2018). It is Declared Rare Flora, specially protected under the *Wildlife Conservation Act 1950* and is listed as Vulnerable under Schedule 3 of the *Wildlife Conservation (Rare Flora) Notice 2016*, meaning that it is likely to become extinct or rare. The species has been collected from about 12 sites, most of which occur within the remote King Leopold Ranges Conservation Park, and it is likely to be present in other similarly inaccessible sites. Total individual numbers are not known. The species is long-lived and fire tolerant. Even with the exclusion of *E. revelata* (described below), recent collections of *E. mooreana* indicate that it is more widespread than previously thought, and that its conservation status should be reassessed, especially considering its longevity, the remote and relatively inaccessible sites on which it occurs, and the lack of any foreseeable threats other than accelerated climate change.

Valid publication and authorship. While generally attributed to Maiden (1914), as Maiden noted, the name itself was published by Fitzgerald (1906) in *The Western Mail* with a brief description and a photograph. This publication has been considered a *nomen subnudum* in the Australian Plant Name Index (https://biodiversity.org.au/nsl/). The descriptive portion of the text is as follows: 'It forms a small crooked tree, with usually mealy-white leaves and pale yellow flowers.' As brief as this description is, it is remarkably diagnostic for species known from the Kimberley region. At the time of description, the only named species with glaucous leaves occurring in the Kimberley region was *E. pruinosa* Schauer, which Fitzgerald collected in 1906, but subsequent to publication of his article in *The Western Mail*. *Eucalyptus pruinosa* is found in the east Kimberley, on low-lying flats, not on rocky sandstone hills. We therefore conclude that the brief statement is sufficient to be diagnostic, especially once combined with the habitat and illustration. Fitzgerald (1906) included a photograph of some of the pressed material he collected. This appears to have comprised three representative pieces, later separated and distributed, with one piece clearly identifiable as the isolectotype sheet now at BM. Fitzgerald did prepare a full description of the species which was published by Maiden (1914). This had been intended for inclusion in Fitzgerald's review of the flora of the Kimberley, but owing to delays in part imposed by World War 1, the review was not published until much later (Fitzgerald

1918). *Eucalyptus mooreana* was shortly afterwards included in Maiden's book series *A critical revision of the genus* Eucalyptus (Maiden 1920).

Lectotypification. Maiden (1920: 101), in the explanation for Figure 179, indicated material from 'Mt Rason' as 'the type'. This has previously been interpreted as an effective lectotypification. There is no citation of a collection number or institution associated with this collection, and we have now located numerous specimens from Mt Rason, with differing collection information (one specimen labelled Aug. 1905, *Fitzgerald* 287 and others labelled Sept. 1905, *Fitzgerald* 1472), so Maiden's (1920) designation is not effective. The acceptance of Fitzgerald (1906) as the place of first publication probably also invalidates Maiden's choice. We select NSW 41842 as the lectotype because this is a good quality, fruiting specimen that represents the typical variant of *E. mooreana*, and is probably the main sheet Maiden was referring to.

Common names. Mountain White Gum, King Leopold Range Mallee, Moore's Gum.

Notes. *Eucalyptus mooreana* is clearly closely related to *E. revelata* (see below) but the two species are easily distinguished both as herbarium specimens and in the field, even from a distance. The mature crown of opposite, sessile, silvery grey, pruinose juvenile foliage of *E. mooreana* is not unique among Kimberley eucalypts; it is also a feature of the variously-related *E. apodophylla* Blakely & Jacobs, *E. ceracea* Brooker & Done and *E. pruinosa*. Of these species, *E. apodophylla* is also a member of *E.* ser. *Subexsertae*, but is distinguished from *E. mooreana* by its better-formed tree habit, non-connate crown leaves, and globular buds with rounded opercula. *Eucalyptus apodophylla* is restricted to seasonally wet flats and floodplains, with a single population known from a valley within the King Leopold Ranges, most populations occurring further north.

Eucalyptus revelata D.Nicolle & R.L.Barrett, *sp. nov.*

Typus: Mount Bell, King Leopold Range, Western Australia [precise locality withheld for conservation reasons], 18 June 1978, *A.S. George* 15149 (*holo*: PERTH 01052861; *iso*: BRI, CANB 15149, K, NSW 304181).

Illustrations. G. Chippendale, *Fl. Austral.* 19: 322, Figure 90l (1988), as *E. mooreana*; A.P. Brown *et al.*, *West. Austral. Threat. Fl.* p. 26. (1998), as *E. mooreana*; Slee *et al.*, *EUCLID Eucalypts of Australia* CD ROM, all *Eucalyptus mooreana* images except upper left image (2006).

Very poorly-formed, scraggy tree or *obligate mallee*, 2–4 m tall; lignotuber present (combination resprouter of Nicolle 2006). *Bark* smooth throughout, decorticating annually, white to slightly salmon pink to pale grey. *Branchlets* not or slightly pruinose, lacking pith glands. *Cotyledons* reniform. *Seedling leaves* opposite, sessile, ovate, glabrous, dull, green, not pruinose. *Mature crown* composed entirely of juvenile leaves. *Juvenile leaves* opposite, sessile, ovate to broad-lanceolate, 35–145 mm long, 32–75 mm wide, concolorous, dull, green to blue-green, not pruinose; tertiary venation very dense; oil glands numerous, unconnected to vein network (island oil glands). *Inflorescences* held erect, 7-flowered; peduncles angular in cross section, stout, 8–20 mm long; pedicels absent or to 1 mm long. *Flower buds* diamond-shaped to ovoid, not pruinose, 9–12 mm long, 5–8 mm diam.; hypanthium smooth; operculum smooth, hemispherical to conical. *Flowers* white, staminal filaments irregularly-flexed in bud; ovules in 6 vertical rows on each placenta. *Fruits* cupular, smooth, not pruinose, 4–8 mm long, 5–8 mm diam.; disc ± level; valves 3, strongly exserted above rim. *Seeds* dark brown to black, obliquely pyramidal to elongate, 1–2 mm long. (Figure 2)

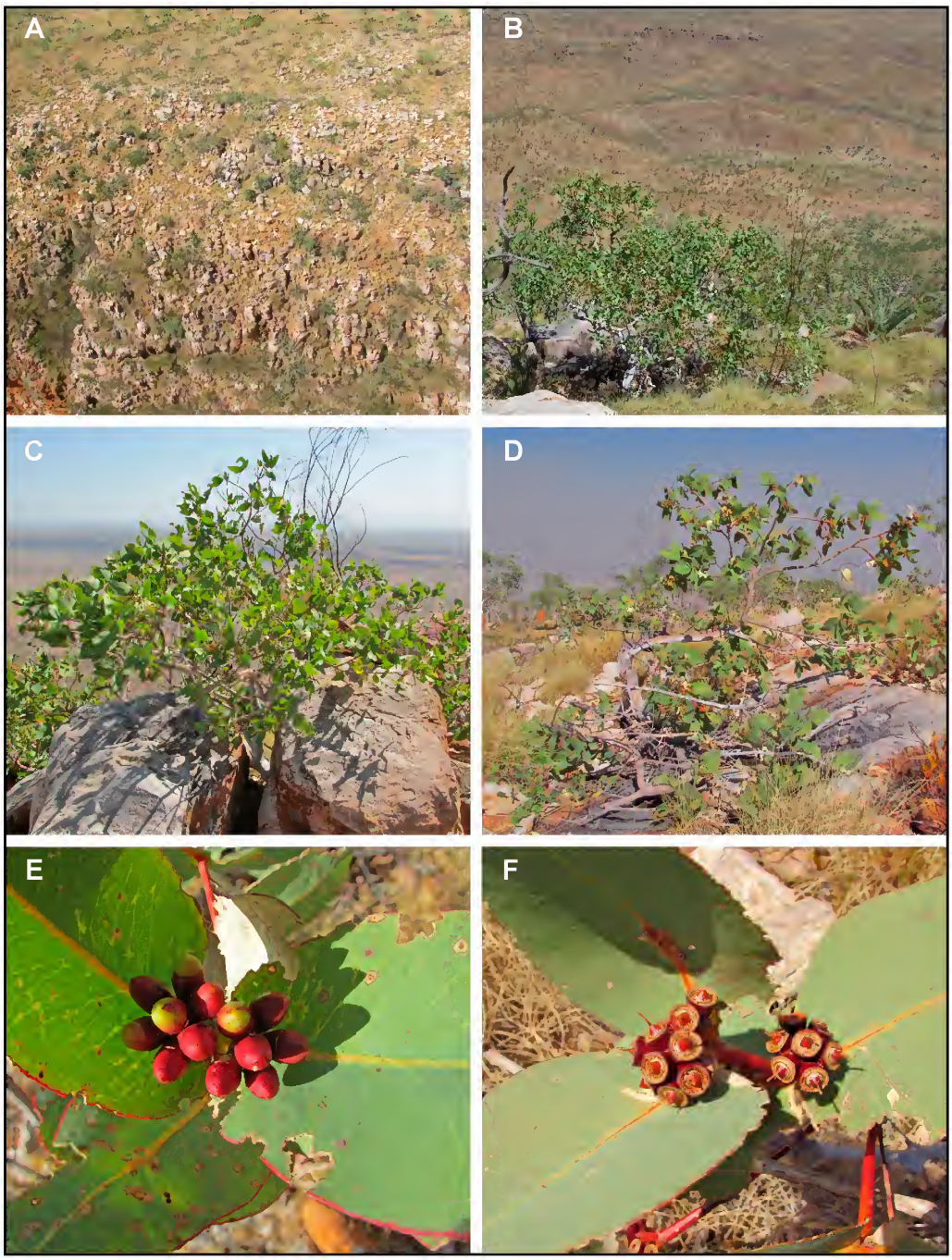

Figure 2. *Eucalyptus revelata*. A – habitat on Bold Bluff; B – habitat and habit on Mt Herbert; C, D – habit of plant on Bold Bluff (note the low sprawling habit (compared to *E. mooreana*) at all sites); E – crown foliage and flower buds; F – crown foliage and immature fruits. Photographs by Tim Willing.

Diagnostic characters. *Eucalyptus revelata* is distinguished within *Eucalyptus* ser. *Subexsertae* by its very poorly-formed tree or sprawling mallee habit, its mature crown of opposite, sessile, often connate, non-pruinose juvenile leaves, its 7-flowered inflorescences, and its conical opercula. Characters distinguishing it from *E. mooreana* are its generally lower, more sprawling habit, its less uniformly-coloured bark, its non- or weakly-pruinose branchlets, its non-pruinose buds and fruits, its green to slightly blue-green, non-pruinose leaves, and its generally smaller fruits.

Specimens examined. WESTERN AUSTRALIA: [localities obfuscated for conservation reasons] Mt Bell, 28 May 1974, *J.S. Beard* 6964 (NSW, PERTH); Mt Bell, 23 May 1967, *E.M. Bennett* 1888 (PERTH); Mt Broome, [20] May 1905, *W.V. Fitzgerald* 830, *p.p.* (NSW); Mt Bell, 30 July 1984, *S.J. Forbes, L.A.S. Johnson & K. Hill* SJF 2752 (CANB, MEL, PERTH); Bold Bluff, July 1967, *C.H. Gittins* 1440 (NSW, PERTH); Mt Bell, 23 May 1967, *J.R. Maconochie* 224 (CANB); Mt Bell, 13 Oct. 1996, *D. Nicolle* 1910 (PERTH); Bold Bluff, 5 June 2006, *T. Sinclair & T. Willing* 10 (CANB, PERTH); Mt Bell, 1 Oct. 2003, *A.V. Slee* 4583 (CANB, MEL, PERTH); cultivated at Canberra (ex *Slee* 4583), 6 Apr. 2004, *A.V. Slee s.n.* (CANB 644786); Bold Bluff, 23 Sep. 2014, *T. Sonneman & T. Willing* 1 (PERTH); Bold Bluff, 23 Sep. 2014, *T. Sonneman & T. Willing* 2 (PERTH); Bold Bluff, 23 Sep. 2014, *T. Sonneman & T. Willing* 3 (PERTH); Bold Bluff, 23 Sep. 2014, *T. Sonneman & T. Willing* 4 (PERTH); Mt Broome, 23 Sep. 2014, *T. Sonneman & T. Willing* 5 (PERTH); Mt Broome, 23 Sep. 2014, *T. Sonneman & T. Willing* 6 (PERTH); Mt Broome, 23 Sep. 2014, *T. Sonneman & T. Willing* 7 (PERTH); Mt Herbert, 23 Sep. 2014, *T. Sonneman & T. Willing* 11 (PERTH); Mt Herbert, 23 Sep. 2014, *T. Sonneman & T. Willing* 12 (PERTH); Gibb River Rd, 5 Sep. 2006, *L.S.J. Sweedman* 7001 (KPBG, PERTH).

Distribution and habitat. Restricted to a localised part of the western King Leopold Ranges in the Kimberley region of Western Australia. The species has been collected from only a handful of sites, from Mt Vincent in the north-west to Mt Broome in the south-east, over a linear range of less than 30 km. It grows on cliffs and steep rocky slopes, and less commonly on the ridges, of the higher sandstone hills and mountains in the ranges, often in quartzite outcrops. Within populations it grows as scattered plants in very open, low woodland or shrubland with *Corymbia cadophora* subsp. *cadophora* and *C. collina*, over a *Triodia* ground storey.

Conservation status. To be listed as Priority Two under the Conservation Codes for Western Australian Flora (A. Jones pers. comm.). *Eucalyptus revelata* was previously included within *E. mooreana*, which is Declared Rare Flora (see above). *Eucalyptus revelata* has been collected from only five mountains, although all occur within the remote King Leopold Ranges Conservation Park, and there may be populations awaiting discovery at other similarly inaccessible sites. Total individual numbers are not known. Although the species is long-lived and fire tolerant, it could still be vulnerable due to its restricted occurrence.

Etymology. The epithet is from the Latin *revelatus* (unveil, lay bare), referring to the absence of white wax covering on the branchlets, leaves, flower buds and fruits, which distinguishes the species from *E. mooreana*.

Notes. We have considered, but rejected, environmental variables as a cause for the morphological distinction between the two variants of *E. mooreana s. lat.* (*E. mooreana s. str.* and *E. revelata*). In particular, the response to wildfire and the associated age and vigour of resultant new vegetative growth was considered as a possible explanation for the differences in pruinosity and leaf colour between the two variants; however, we were able to eliminate this as a reason for the morphological differences by examining photographs of both variants at various post-fire regrowth stages, even on single mountain ridges.

Specific recognition of this taxon is considered appropriate, as the distribution of *E. mooreana* and *E. revelata* is not a simple geographical replacement pattern, and hybrids and intergrades between the two have not been recorded. Although the two species do not usually grow in mixed stands, their overall distributions mostly overlap, and both variants do occur on some mountains, such as on Mt Bell, where the two species grow on slopes with different aspects, and also on Mt Broome. The specimen label for *S.J. Forbes et al.* SJF 2752 indicates a probable mixed population ('variably glaucous or non glaucous within population') on Mt Bell.

Acknowledgements

We are indebted to Tracy Sonneman (District Nature Conservation Coordinator for the West Kimberley District at DBCA) for bringing the two variants of *E. mooreana* to our attention. We also thank Tim Willing (Broome) and Tracy Sonneman for their recent collections and the in-situ photography of two variants of *E. mooreana* from a number of remote sites.

References

Briggs, J.D. & Leigh, J.H. (1996). *Rare or threatened Australian plants*. 1995 revised edn. (CSIRO Publishing: Collingwood, Victoria.)

Brooker, M.I.H. (2000). A new classification of the genus *Eucalyptus* L'Hér. (Myrtaceae). *Australian Systematic Botany* 13: 79–148.

Brooker, M.I.H. & Kleinig, D.A. (1994). Field guide to eucalypts. Vol. 3. Northern Australia. 1st edn (Inkata Press: Sydney.)

Brooker, M.I.H. & Kleinig, D.A. (2004). Field guide to eucalypts. Vol. 3. Northern Australia. 2nd edn (Bloomings Books: Melbourne.)

Brooker, M.I.H. & Nicolle, D. (2013). *Atlas of leaf venation and oil gland patterns in the eucalypts*. (CSIRO Publishing: Collingwood.)

Brown, A.P., Thomson-Dans, C. & Marchant, N.G. (1998). *Western Australia's threatened flora*. (Department of Conservation and Land Management: Perth.)

Chippendale, G.M. (1988). *Eucalyptus, Angophora*. *In*: A.S. George (ed) *Flora of Australia. Volume 19, Myrtaceae* - Eucalyptus, Angophora. (Australian Government Publishing Service, Canberra.)

Fitzgerald, W.V. (1905). *W.V. Fitzgerald's diary of the Kimberley Trigonometrical Expedition, April 5 to October 25, 1905*. (Unpublished, Battye Library, Perth.)

Fitzgerald, W.V. (1906). Some species of West Kimberley plants. *The Western Mail (Perth)* 21(1066) 2 June 1906: 10, 24–25, 28.

Fitzgerald, W.V. (1918). The botany of the Kimberleys, north-west Australia. *Journal and Proceedings of the Royal Society of Western Australia* 3: 102–224.

Gardner, C.A. (1979). *Eucalypts of Western Australia*. (Western Australian Department of Agriculture: Perth.)

Hopper, S.D., van Leeuwen, S., Brown, A.J. & Patrick, S. (1990). *Western Australia's endangered flora*. (Department of Conservation and Land Management: Perth.)

Maiden, J.H. (1914). Notes on *Eucalyptus* (with descriptions of new species) No. 2. *Journal and Proceedings of the Royal Society of New South Wales* 47: 217–235.

Maiden, J.H. (1920). *A critical revision of the genus* Eucalyptus. Vol. 5, Part 43. (Government Printer: Sydney.)

Nicolle, D. (2006). A classification and census of regenerative strategies in the eucalypts (*Angophora, Corymbia* and *Eucalyptus* - Myrtaceae) with special reference to the obligate seeders. *Australian Journal of Botany* 54(4): 391–407.

Nicolle, D. (2015). Classification of the eucalypts (*Angophora, Corymbia* and *Eucalyptus*) Version 2. http://www.dn.com.au/Classification-Of-The-Eucalypts.pdf [Online, accessed 15 April 2017].

Rye, B.L. (1992). Myrtaceae. *In*: Wheeler, J.R. (ed.) *Flora of the Kimberley region*. pp. 499–546. (Department of Conservation and Land Management: Perth.)

Slee, A.V., Connors, J., Brooker, M.I.H., Duffy, S.M. & West, J.G. (2006). *EUCLID Eucalypts of Australia*. CD ROM. Centre for Plant Biodiversity Research. (CSIRO Publishing: Melbourne.)

Smith, M. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 24 January 2018].

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By their fruit you will recognise them: species notes and typifications in Western Australian species of *Opercularia* (Rubiaceae: Anthosperminae)

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Abstract

Markey, A.S. By their fruit you will recognise them: species notes and typifications in Western Australian species of *Opercularia* (Rubiaceae: Anthosperminae). *Nuytsia* 29: 119–140 (2018). An examination of herbarium collections, type material and reference to original species descriptions has found that several species names of *Opercularia* Gaertn. have been misapplied in Western Australia. This nomenclatural confusion stems from a combination of missing types, a lack of reference to either types or correctly identified specimens, and no recent revisions of the genus. Previously presumed to be extinct, *O. acolytantha* Diels is neotypified and discussed here as an extant species endemic to the Mallee and Esperance bioregions of Western Australia. *Opercularia hirsuta* Benth. is found to be a far rarer species than previously thought, with no material matching the type collected since the 1860s. *Opercularia nubicola* A.S.Markey is described as a new species with affinities to *O. aspera* Gaertn. *Opercularia rubioides* Juss. is reduced to synonymy with *O. aspera*,which is excluded from Western Australia. *Opercularia scabrida* Schltdl. is also excluded from Western Australia. This paper provides updated notes, illustrations and a key to Western Australian species of *Opercularia*. Characteristics of the infructescence, fruits and seed are diagnostic for these species and are illustrated here for this purpose.

Introduction

Opercularia Gaertn. (Rubiaceae: Anthosperminae) is a genus of 18 species of perennial low shrubs or herbs endemic to southern Australia. Eleven of these species are all endemic to the south-west of Western Australia (Western Australian Herbarium 1998–; Council of Heads of Australasian Herbaria [CHAH] 2006–). Plants have a characteristically foetid odour when the leaves are crushed; hence 'stinkweed' being one vernacular name for the genus. *Opercularia* is named for its unusual infructescence, which is either a simple capsular syncarpium (in some species) or more commonly a compound globular capsiconum (Spjut 1994) of several capsular syncarpia, each of which formed from several sessile fruits fused by their pericarps (Jussieu 1804; Bentham 1867). The syncarpium itself is a two-valved compound capsule, the inner valves fused together to form an apical operculum which abscises from the compound capsule to release the seeds. Two species (*O. acolytantha* Diels and *O. liberiflora* F.Muell.) lack the characteristic operculum and fruits fused into syncarpia, instead having sessile free (unfused) flowers and single fruits arranged on a common receptacle into a solitary, globular capitulum.

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There have been few updates addressing Western Australian species of *Opercularia* since Mueller (1863–4), Bentham (1867) and Diels and Pritzel (1904–5), apart from three regional flora treatments (Blackall & Grieve 1982; Rye 1987; Wheeler 2002) and a new species described by Keighery (1999). This paucity of recent work has resulted in some nomenclatural confusion and errors in applying names to collections in Western Australia. This was found to be particularly evident among *Opercularia* specimens at the Western Australian Herbarium (PERTH) for *O. acolytantha*, *O. hirsuta* Benth. and *O. rubioides* Juss. Furthermore, while eastern states herbaria house several collections of *O. scabrida* Schltdl., none exist at PERTH. Misidentifications of collections have been compounded by a lack of reference to either the type material or older collections cited by Bentham (1867) and Mueller (1863–4), probably because these are held by interstate or overseas herbaria or, in the case of *O. acolytantha*, the type being missing. Three of these four species are of conservation concern; *O. acolytantha* has been declared extinct (Department of the Environment and Energy 2018), while *O. hirsuta* and *O. rubioides* are poorly known taxa with Priority Two and Priority Three state conservation listings, respectively (Smith & Jones 2018). This confusion in identifying species of Western Australian *Opercularia* is greatly hampering the assessment of conservation status, the monitoring of known populations and the survey for new populations of these rare and poorly known species. This research paper aims to assess the taxonomic and conservation status of these four problematic species. While a modern revision of the genus is desirable, for the interim this paper provides updated notes, typifications, morphological descriptions, illustrations and an updated key for Western Australian species.

Methods

Specimens of *Opercularia* at the Western Australian Herbarium (PERTH) and National Herbarium of Victoria (MEL), and loans from the Australian National Herbarium (CANB) were examined using light stereomicroscopy, and further information was gained from scans of sheets held at Muséum National d'Histoire Naturelle, Paris (P), Kew (K), and the Natural History Museum of the United Kingdom (BM). Measurements are mostly based on dried specimens, with additional measurements and observations obtained from alcohol preserved and fresh material of *O. acolytantha*, *O. echinocephala* Benth., *O. hispidula* Endl., *O. vaginata* Juss. and *O. volubilis* Benth. Fieldwork was undertaken at several localities (Porongurup National Park, South Stirling Nature Reserve, Stirling Range National Park, Cape Le Grand National Park, and the Oldfield River estuary) to relocate populations of *O. acolytantha*, *O. hirsuta* and *O. rubioides*.

Terms used here to describe outgrowths of the indumentum are papillae (protuberances that are slightly emergent epidermal cells or a projection of the epidermal cell wall) and hairs (elongate, unbranched trichomes) (*cf.* Hewson 1988). It is acknowledged that the distinction between these two groups is not clear-cut, as papillae may grade into very short, stiff hairs with broad bases (this is particularly so for *O. aspera* Gaertn. and *O. nubicola* A.S.Markey). While these two broad terms are used here, a refinement of terms for the range of features that comprise the indumentum of *Opercularia* is warranted in any future revisions of the genus.

Differences in seed morphology among Western Australian species are illustrated in Figure 1. The term capsiconum, as defined by Spjut (1994) applies to the globular compound infructescence found in species where several capsular syncarpia have fused into a single spherical unit.

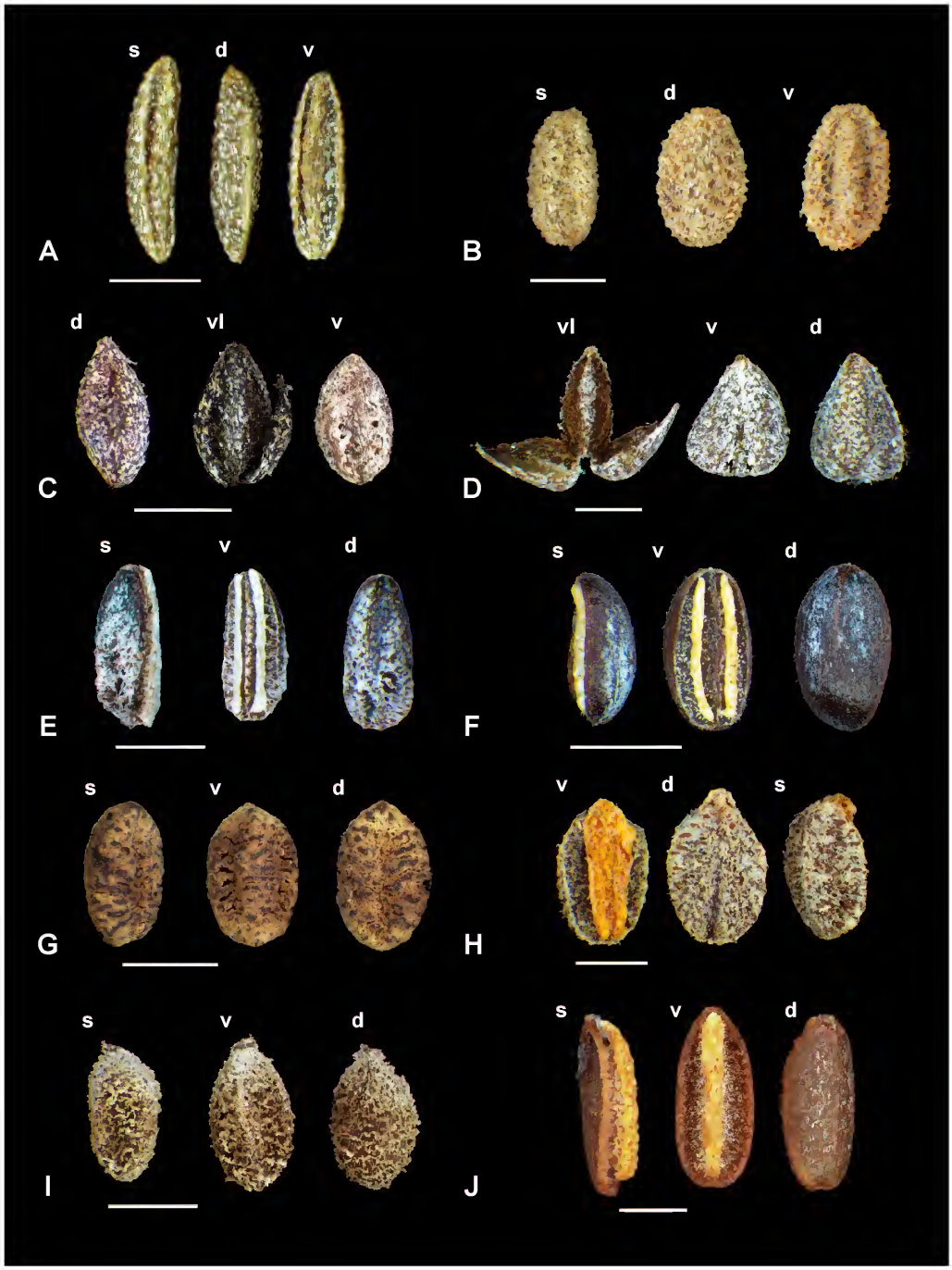

Figure 1. Seeds of Western Australian species of *Opercularia* showing side (s), ventral (v) and dorsal (d) surfaces, and lateral appendages separated from the ventral keel (vl) in two species. A – *O. hirsuta* (*G. Maxwell s.n.*); B – *O. hispidula* (*P.G. Wilson* 3974); C – *O. acolytantha* (*W.R. Archer* 1212936); D – *O. vaginata* (*G. Keighery* 13019); E – *O. nubicola* (*A.S. Markey & S. Dillon* SR 9656); F – *O. echinocephala* (*A. Markey & S. Dillon* NIB 9643); G – *O. liberifolia* (*A.S. George* 6878); H – *O. volubilis* (*A.S. George s.n.*); I – *O. spermacocea* (*G.J. Keighery & N. Gibson* 304); J – *O. apicifolia* (*P.G. Wilson* 3967). Scale bars = 1mm. Photographs by A. Markey.

Key to Western Australian species of *Opercularia*

1. Individual flowers and fruit free on common receptacle of a globular inflorescence; operculum absent, fruits separating from receptacle as an entire dispersal unit

2. Peduncles elongate (5–30 mm); stems glabrous or scabrous, leaves scabrous; leaves linear, ensiform or narrowly ovate; calyx scabrous (less commonly glabrous), lobes 0.7–1.0 mm long on fruit; fruits indehiscent utricles; seeds with deep furrows forming appendages around the keel, dark brown with white flecks; erect low, rhizomatous, short-lived perennial herb or subshrub ..... **O. acolytantha**

2: Peduncles absent to very short (0–2 mm); stems and leaves densely villous, hairs long, soft and white; leaves ovate or elliptic; calyx villous, lobes 2.0–2.5 mm long on fruit; fruit a capsule dehiscing by four valves; seeds with shallow furrows and an indistinct keel, pale to mid-brown; prostrate, compact, rosette-forming, herbaceous annual ..... **O. liberiflora**

1: Ovaries of several flowers coalesced into a unit and arranged either singly or with other capitula on a globular inflorescence; basic unit of fruit a capsular syncarpium with the inner valves forming an operculum (lid) which separates from outer valves by operculate dehiscence to release the seeds

3. Peduncles terminal or axillary, terminal peduncles erect or nearly so, 10–60 mm long, slightly to considerably longer than subtending leaves; leaves linear, narrowly ovate or narrowly obovate, sessile or near-sessile; inflorescence a compound capitulum, infructescence a capsiconum

4. Plants densely covered in long, soft, white hairs; leaves linear or narrowly oblanceolate, apex acute to obtuse; seeds narrowly obovate or narrowly elliptic, prominently and conspicuously furrowed and keeled, light brown with white flecks, rugulose or tuberculate, not scurfy ..... **O. hirsuta**

4: Plants scabrous to glabrous; leaves filiform, linear or narrowly ovate, apex acute to apiculate; seeds obovate or elliptic in outline, furrows and keel present but inconspicuous and concealed, dark-brown, scurfy and rugose

5. Terminal and axillary peduncles distinctly erect, thick, 20–60 mm long; seeds with deep ventral furrows forming appendages around and tightly adpressed to the keel; sparsely to moderately leafy, openly branched, lax subshrubs, with leaves arranged in pairs at widely spaced (10–50 mm) nodes; leaves (particularly in upper half of stem) long (20–35 mm long); calyx lobes on capsiconum narrowly triangular, 1–3 mm long; florets all fused above the ovary and level with calyx lobes ..... **O. vaginata**

5: Terminal peduncles erect to slightly decurved, axillary peduncles recurved, thin, usually <20 mm long; seeds with very shallow furrows and a small keel; densely leafy, tightly branched, compact subshrubs, with leaves mostly clustered in fascicles on short branchlets, all leaves short (15–20 mm long); calyx lobes on capsiconum broadly triangular, 1–2 mm long; florets fused below calyx lobes, so that part of the ovary walls and calyx tubes project beyond the capsiconum ..... **O. spermacocea**

3: Peduncles terminal or axillary, all recurved, 1–20 mm long, shorter than subtending leaves; leaves narrowly ovate to ovate (*O. apicifolia* can be linear), sessile or petiolate; inflorescence either a simple or compound capitulum, infructescence either a capsular syncarpium or a capsiconum.

6. Twining climbers with weak trailing or climbing stems; plants more or less glabrous; leaves large (30–60 mm long), thin, distinctly petiolate; capitula large (3–5 florets per capitulum, 4–6 capitula per compound capitulum); stipules

long (5–10 mm) and recurved; seed rugose, mature seed usually with single, thick, linear elaiosome covering the thin ventral keel, thin ridge on dorsal surface, ventral furrows broad ..... **O. volubilis**

6: Erect subshrubs or perennial herbs, not climbers; plants glabrous, scabrous or hirsute; combination of characters not as above

7. Leaves sessile or very shortly petiolate, with recurved or revolute margins; plants robust, stems stout and stiff

8. Leaves small (2–6 mm long), ovate, glabrous, coriaceous, with distinctly recurved to revolute margins. [seed not seen] (Nullarbor; coastal limestone cliffs)..... **O. loganioides**

8: Leaves not as above, notably scabrous at least on upper surface and margins

9. Plants with glabrous to scabrous stems, leaves scabrous on upper surface and with thickened, scabrous and minutely recurved margins, stipules glabrous with ciliate margins, indumentum of papillae and short hairs (0.1–0.3 mm long); capsiconum (including corolla and calyx lobes) glabrous and not appearing echinate; seeds obovate in outline, dark brown and flecked with white, rugulose and scurfy, dorsal surface not rounded, sometimes cristate..... **O. nubicola**

9: Plant densely and conspicuously hispid or setose; stems, stipules, leaves and flowers covered with long, stiff bristles (0.5–2.0 mm long), leaf margins distinctly hispid and recurved or revolute; capsiconum (including calyces) covered in stiff bristles, appearing echinate; seeds elliptic in outline, dark brown, dorsal surface rounded and smooth ..... **O. echinocephala**

7: Leaves distinctly petiolate (can be shortly petiolate) with flat to recurved margins; plants delicate, stems slender and flexible

10. Leafy plants with sparsely to densely hirsute, pilose or villous stems and leaves; leaves ovate to broadly ovate, or broadly obovate, highly variable in size, 10–40(–50) mm long; capitula simple or compound, with few (4–8) to many (15–>20) flowers; seed light brown, dorsal and ventral surfaces distinctly rugose, ventral surface with two shallow furrows; elaiosome absent, seed edge not demarcated from seed body..... **O. hispidula**

10: Almost leafless to few-leaved plants with glabrous or minutely scabrous stems and leaves; leaves narrowly lanceolate or linear, small, 5–15(–20) mm long; capitula simple with consistently few (3–5) flowers; seed dark brown, dorsal surface rounded and relatively smooth or slightly wrinkled, ventral surface wrinkled with two deep furrows and a single, thick, linear elaiosome obscuring the keel, and distinctive rim on seed edge..... **O. apiciflora**

Species notes, typifications and taxonomy

Opercularia acolytantha Diels, *Bot. Jahrb. Syst.* 35: 547 (1905). *Type citation*: 'Hab. in distr. Eyre a sinu Esperance Bay circ. 60km septentrionem versus in apertis aridus arenosis fruct. m. Novemb. (D. 5967).' (*holotype*: B *n.v.*, destroyed in WWII). *Type*: Mt Heywood, Western Australia [precise locality withheld for conservation reasons], 12 December 1992, *W.R. Archer* 1212926 (*neo*, here designated: MEL 2041551!).

Low, semi-woody, short-lived perennial *herb* or *subshrub*, (4–)5–10(–16) cm tall, with weak taproot 4–10(–13) cm long, suckering from lateral roots. *Stems* erect, arising singly or in multiples from base, simple or branched, glabrous to scabrous, ribbed-sulcate. *Leaves* opposite, simple, sessile to near-sessile,

leaf abscission zone absent, (4–)6–15(–20) mm long, (0.6–)1.0–2.5(–3.7) mm wide, length:width ratio 4–15, lamina concolorous, green with red apices, straight or falcate, linear, ensiform or narrowly ovate, minutely and sparsely scabrous to scabrous; apex acute–mucronulate; margins flat, entire; seedling leaves relatively larger, obovate and petiolate. *Hairs* short, stiff, straight, erect bristles *c.* 0.3 mm long, on leaves, calyx, ovary and (less frequently) stems and peduncles, *papillae* occasionally found on peduncles. *Stipules* interpetiolar, triangular-bifurcate, fused with leaf bases into prominent collar, red, becoming brown and scarious with age, +/- glabrous; lobes (1–)2–4, with apical colleters. *Inflorescence* a globular capitulum, 7–10 mm wide in flower, 4–8 mm wide in fruit, 15–30 flowers per capitulum, capitula often subtended by a pair of leaf-like bracts 1–6 mm long, occasionally secondary capitula arising on a peduncle emerging from the base of the primary capitulum. *Peduncles* 5–30(–50) mm long, erect in flower, further elongating during maturity and becoming decurved to strongly decurved in fruit, glabrous or (less frequently) scabrous. *Flowers* sessile on receptacle, separate from one another, bisexual or with female-only flowers, bisexual flowers protogynous, female flowers with staminodes. *Calyx* sparsely scabrous (occasionally glabrous), green, calyx tube adnate to ovary; lobes 5, becoming purple-tipped, unequal for the most part, 2 major (1.2–2.0 mm long) and 3 minor (0.6–1.1 mm long), ovate-triangular with acute apices, bearing a pair of minute denticles (<0.1 mm long) with apical colletors at base of each lobe. *Corolla* glabrous except for minute papillae on lobe margins, purple to cream or green; on female flowers tubular, barely exceeding calyx; tube 0.7–0.8 mm long; lobes 4 or 5, 0.2–0.8 mm long, on bisexual flowers campanulate, exceeding calyx; tube 0.4–1.0(–1.6) mm long; lobes 4 or 5, 0.7–1.0 mm long. *Staminodes* 4 per female flower, 0.3–0.4 mm long. *Stamens* 4, free to base of corolla; filaments 2.2–3.1 mm long at maturity, exserted 1.0–1.8 mm beyond corolla; anthers 0.9–1.6 mm long, cream-yellow with blue flecks, dehiscing by longitudinal slits, with apical process. *Ovary* inferior, scabrous, 0.8–1.0 mm long, uniloculate with single ovule, tubular to funnelform. *Style* 2.5–5.2 mm long, 1.0–4.0 mm exserted, bifid for 1/2–4/5 length, filiform, purple, papillose, papillae 0.20–0.25 mm long. *Fruit* a utricle encasing a single seed, unfused and separate from one another on capitulum, sessile on receptacle, indehiscent, (1.2–)1.5–2.6(–2.9) mm long, (0.8–)1.1–1.9 mm wide, triangular in outline, crowned by persistent calyx lobes 0.7–1.0 mm long, scabrous to sparsely hispid, becoming inflated and scarious with maturity. *Seeds c.* 1.4–2.0 mm long, 0.5–2.0 mm wide and (0.5–)0.7–0.9 mm tall, elliptic, obovate or obtriangular in outline, trigonous with two deep furrows on the ventral face forming lateral appendages around a ventral keel, surface dark brown with white flecks, rugulose and covered in short, scurfy hairs. (Figures 1C, 2A–G, 3)

Diagnostic features. *Opercularia acolytantha* is distinguished from other species by the combination of the following characters: flowers and fruit unfused and free from one another on a common receptacle, infructescence a globular capitulum on decurved, elongate peduncles, capitula lacking opercula, fruit shed as a single, indehiscent utricle, leaves linear and scabrous, leaf margins not revolute, seed with two lateral appendages often obscured by scurfy scales and lacking an elaiosome.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 12 Dec. 1992, *W.R. Archer* 1212921 (MEL); 24 Jan. 1993, *W.R. Archer* 2401936 (MEL); 25 Oct. 2001 *G.F. Craig* 5525 (PERTH); 16 Oct. 1968, *N.N. Donner* 3049 (PERTH); 16 Oct. 1968, *Hj. Eichler* 20293 (PERTH); 30 Oct. 1965, *A.S. George* 7032 (PERTH); 10 Nov. 2013, *M. Hoggart* 9/1113; 28 Oct. 1985, *G.J. Keighery* 7311 (PERTH); 24 Oct. 1991, *G.J. Keighery* 12558 (PERTH); 1 Oct. 2012, *A.S. Markey & S. Dillon* SR 9650 (PERTH); 1 Oct. 2012, *A.S. Markey & S. Dillon* SR 9651 (PERTH); 3 Oct. 1973 *K. Newbey* 3855 (PERTH); 6 Oct. 1986, *K. Newbey* 11249 (PERTH); 6 Nov. 1968, *J.W. Wrigley s.n.* (CANB).

Phenology. Flowering occurs in September and October, followed by fruiting from October to December. After a dry spell in the later winter of 2012, fruits were found to have aborted in a population near

Figure 2. *Opercularia acolytantha*. A – flowering and fruiting plant showing the habit (plant *c*. 15 cm tall); B – flowering simple capitulum with styles exserted from florets; some florets are unisexual, some are protogynous and bisexual; C – single, intact, indehiscent fruit and extracted seeds showing dorsal (d) and ventral (v) surfaces (*W.R. Archer* 1212936; MEL 2041551); D – dried bisexual floret in male phase that has separated from the capitulum; E – intact pickled female floret with part of perianth removed to show staminodes (arrowed); F – stipules; G – fruiting capitulum (*M. Hoggart* 9/1113); H – fruiting capitulum (capsiconum) of *O. vaginata* for comparison. Scale bars = 5 mm (B, H), 3 mm (G), 2 mm (F), 1 mm (C–E). Photographs by A. Markey.

South Stirling. Typical for the genus, the bisexual flowers of *O. acolytantha* have been observed to be protogynous, and both bisexual and unisexual (female) flowers have been observed on the same head. Capitula with flowers both bisexual and female or entirely female-only have been observed in a population near South Stirling, but capitula with male-only flowers were not observed in that population.

Distribution and habitat. Found in scattered localities between Mount Barker and north-east of Esperance, in southern Western Australia (Figure 4). Occurs on sandplains, sandy flats, sands overlying

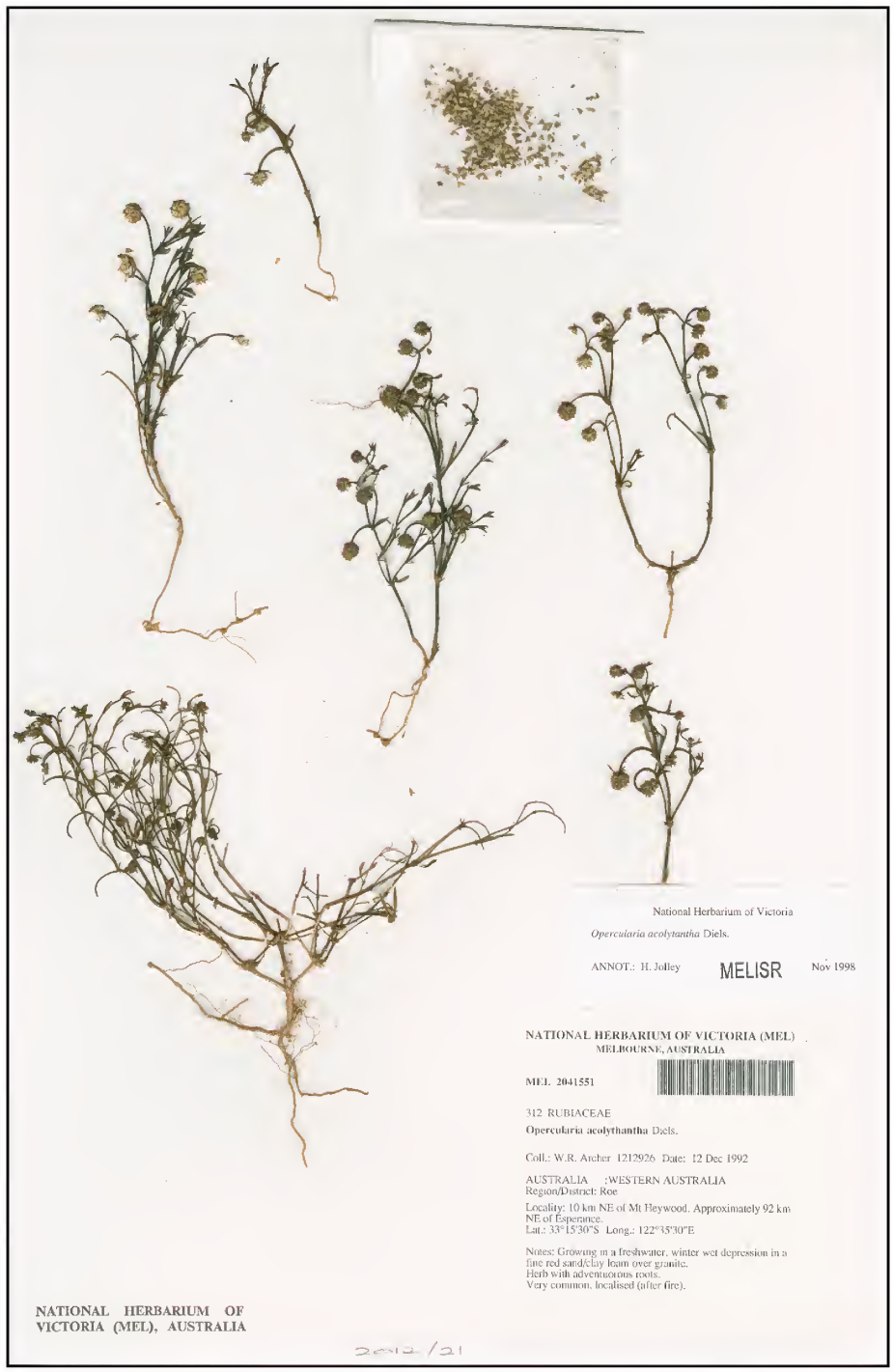

Figure 3. Neotype of *Opercularia acolytantha* (*W.R. Archer* 1212926; MEL 2041551). Reproduced with permission from the National Herbarium of Victoria (MEL), at the Royal Botanic Gardens Victoria.

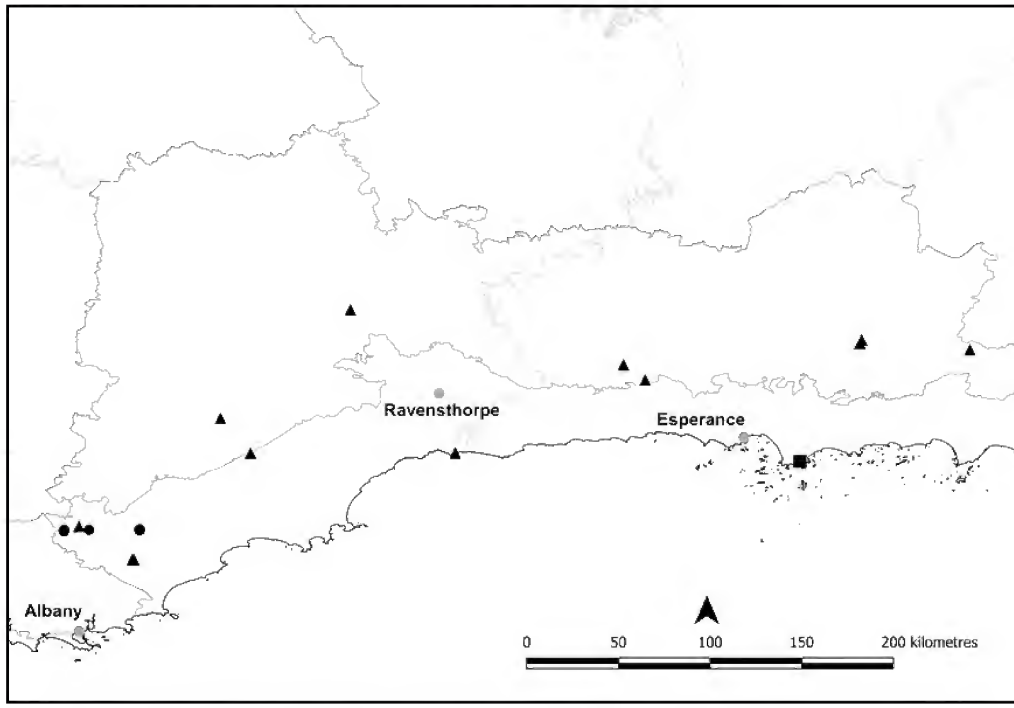

Figure 4. Distributions of *Opercularia hirsuta* (■), *O. acolytantha* (▲) and *O. nubicola* (●) in southern Western Australia. Only the one, most certain, location for *O. hirsuta* is mapped, as there are uncertainties as to the exact position of the other records for this species at Young and Oldfield Rivers and Esperance Bay.

laterite and clay, deep white sands and freshwater winter-wet sands over granite. Recorded from mallee and mallee-shrubland vegetation and coastal mallee-heath dominated by *Eucalyptus pleurocarpa* and *E. angulosa*, and in swamp yate (*E. occidentalis*) mallee.

Conservation status. Currently Nationally Listed as Extinct under the *Environment Protection and Biodiversity Conservation Act 1999* (Department of the Environment and Energy 2018), and until 2018 listed in Western Australia as Extinct under Schedule 4 in the *Wildlife Conservation Act 1950* (Western Australian Minister for the Environment 2015). The species was recently recognised as extant in Western Australia and listed as Priority Three (Smith 2018; Smith & Jones 2018) as a result of this study.

Typification. Neotypification is required since the holotype of *O. acolytantha* at B is presumed destroyed in the fire that followed a wartime bombing raid (Brown *et al.* 1998; Orchard 1999; Botanical Museum Berlin-Dahlem 2010) and no duplicate material has emerged to date. The neotype corresponds with the original description of the species and was collected close to the original locality.

Similar species. Collections of *O. acolytantha* have been previously misidentified either as *O. rubioides* or *O. vaginata*. In particular, *O. vaginata* and *O. acolytantha* can be easily confused because they share a similar growth form, similar linear to narrowly ovate leaves, globular capitula on elongate peduncles, and sulcate, glabrous or sparsely scabrous stems and peduncles. Together with *O. liberiflora*, *O. acolytantha* is distinguished from all other species of *Opercularia* by having flowers on the capitulum unfused and free. The fruits remain separate on the capitulum, lack opercula, are indehiscent,

become inflated at maturity and eventually fall from the receptacle (Figure 2). In comparison, the fused fruits of *O. vaginata* dehisce by opercula to release the seed (Figure 2). Both species have seed which lack elaiosomes and share the unusual seed character of two lateral appendages formed by deeply invaginated lateral furrows, but the seeds of *O. vaginata* are distinctly more obtriangular in outline (Figure 1). *Opercularia acolytantha* has strongly decurved and shorter fruiting peduncles as opposed to the elongate and erect fruiting peduncles of *O. vaginata*, and the capitula are 1–0.8 times the width of those of *O. vaginata* (Figure 2). Plants of *O. acolytantha* tend to be relatively short in height (5–10 cm tall) and are more sparsely stemmed than *O. vaginata*, which can grow to a height of 10–30 cm and form sparsely-stemmed to dense, bushy subshrubs or robust perennial herbs.

Notes. Prior to this current investigation PERTH had no collections identified as *O. acolytantha*. As the species was known from a single specimen (the type), the species has been listed as presumed extinct by both Western Australian and Federal authorities (Brown *et al.* 1998; Walter & Gillet 1998; Hopper *et al.* 1990; Craig & Coates 2001; Department of the Environment and Energy 2018). Despite five collections at either CANB or MEL being redetermined or confirmed as *O. acolytantha* within the past 40 years, neither typification nor reassessment of the conservation status of this species had been attempted before this current study. A search of material at PERTH and MEL has located several collections which fit the description of *O. acolytantha* by Diels (Diels & Pritzel 1904–5). This species is assumed to have been overlooked in collections and field studies for three reasons: there is no type for reference, it is a short-lived perennial, and it is morphologically similar to and easily confused with *O. vaginata*. *Opercularia acolytantha* is difficult to observe as plants grow and flower only within 1–3 years after fire. Sterile plants potentially of this species were located within one year after fire at a recollection site in the Stirling Range, but flowering plants were found 2–3 years after fire at another location south of the Stirling Range. Observations recorded on herbarium sheets (MEL 2041551, MEL 2041553) note that populations are common after fire , and transition from being locally common to completely absent from sites within two years after being first sighted (MEL 2041552).

Atypically for the genus, the fruit of *O. acolytantha* becomes a dry, scarious and inflated utricle at maturity (Figure 2). The seed is retained within the indehiscent fruit, which readily detaches from the receptacle and is assumed to be shed in its entirety as a diaspore. These relatively light-weight diaspores may be dispersed by wind or surface rainwater runoff to some degree, or the rigid and even-hooked calyx lobes may even facilitate ectozoochorous dispersal. Although lacking the elaiosome found on the seed of the presumably myrmecochorous species *O. echinocephala*, *O. volubilis* and *O. nubicola* (Figure 1) (Berg 1975; Lengyel *et al.* 2009), seed-harvesting ants or other animals may disperse these after they fall from the capitulum. More field observations are required to verify these postulates and to determine both the distances and means by which fruit are dispersed and seed liberated from the indehiscent fruit.

The vernacular name of this species is Esperance Dog Weed.

Opercularia hirsuta Benth., *Fl. Austral.* 3: 434 (1867). *Type citation*: 'Lucky Bay, Oldfield and Young rivers, Esperance Bay, *Maxwell*'. *Type specimens*: Lucky Bay [Western Australia], *s. dat.*, *G. Maxwell s.n.* (*syn*: MEL 2296181!; K 000772252 image!); Oldfield and Young River, Esperance Bay [Western Australia], *s. dat.*, *G. Maxwell s.n.* (*syn*: MEL 2296180!).

Erect *subshrub* or perennial, weakly or semi-woody *herb*, *c.* 30–50 cm tall. *Stems* virgate, sulcate, villose; *hairs* simple, non-septate, 2.5–3.0(–3.5) mm long, sometimes twisted, soft, almost silky. *Leaves* few on stems, opposite, simple, sessile, leaf abscission zone not evident, villose, 14–16(–19) mm

long, 2.0–3.5(–4.5) mm wide, length:width ratio 4–7, straight, linear or narrowly obovate; apex acute to obtuse; margins entire, flat, thick but not recurved; midrib visible abaxially (may be obscured by hairs), obscure adaxially; lateral veins obscure or absent. *Stipules* interpetiolar, fused with leaf bases into prominent collar, obscured by villose hairs; denticles 1 or 2 major and 0–2 minor, with apical colleters. *Inflorescence* a globular compound capitulum of several fused capitula, each capitulum with 4–6 fused florets, 15–25 florets per compound capitulum, 7–9 mm wide in late flower and early fruit, subtended by a pair of leaf-like, linear bracts 5–10 mm long. *Peduncles* erect in both flower and fruit, (7–)15–30(–60) mm long. *Flowers* fused to one another, sessile on common receptacle, bisexual, protogynous. *Calyx* densely hairy, 2.3–2.5 mm long; lobes 5, narrowly triangular with acute apex, equal, 0.5 mm long on mature, male-phase florets, shorter on younger, female-phase florets. *Corolla* densely hairy on abaxial surface, glabrous adaxially, free, starting as tubular and becoming urceolate in later developmental stages, exceeding calyx; tube 2.3–2.4 mm long; lobes 4–5, 0.7–0.9 mm long. *Stamens* 4 or 5, barely exserted beyond corolla; filaments *c.* 2.0–2.5 mm long, inserted at base of corolla; anthers 1.5–2.0 mm long, with apical process, dorsifixed, longitudinally dehiscent. *Style* deeply bifid, filiform, papillose, 3.0–3.5 mm long, exserted from corolla by 1.5–2.0 mm. *Ovary* inferior, villose, unilocular, one ovule per locule, fused to adjacent ovaries. *Fruit* a globular capsiconum of several (*c.* 3–6) fused syncarpia, each capsular syncarpium dehiscing by an operculum, covered with persistent calyx lobes 1.0–1.2 mm long, densely hairy. *Seeds* 2.0–2.3 mm long, 0.5–0.7 mm wide, narrowly obovate or narrowly elliptic in outline, with two ventral furrows, one on either side of a ventral keel, appearing bisulcate, glabrous, rugulose to tuberculate, light brown, covered in white flecks. (Figures 1A, 5, 6)

Diagnostic features. *Opercularia hirsuta* is distinguished from other species by having the combination of an elongate, erect peduncle subtending globular inflorescences, fused florets, a dense, villous indumentum covering stems, leaves, flowers and fruit, sessile, linear or narrowly obovate leaves, and bisulcate, fusiform seeds lacking an elaiosome.

Specimens examined. The description is based on examination of type gatherings and Bentham's original description. No specimens matching this description have been found at PERTH.

Phenology. The Maxwell specimens are in flower and fruit, but no information is provided which indicates the season during which they were collected. If these specimens were collected when Maxwell accompanied the Dempster brothers on their expedition from Albany to Point Culver in 1863, the timing of collection would have been between May and June (Anon. 1863).

Distribution and habitat. Restricted to the Esperance IBRA region of south-eastern Western Australia (Figure 4). Locations given are Lucky Bay, Oldfield River, Young River and Esperance Bay. Little information was given on Maxwell's collections except 'moist flats' and 'on banks of a small brook', which suggests *O. hirsuta* may occupy riverine habitats or freshwater seeps into sandy substrates adjacent to beaches or rivers. Recent attempts failed to locate this species at Cape Le Grand along the banks of a small freshwater creek (Markey 2012), and along the lower reaches of the Oldfield River estuary.

Conservation status. *Opercularia hirsuta* is currently listed in Western Australia as a poorly known species with Priority Two conservation status (Smith & Jones 2018). An examination of all *Opercularia* collections at PERTH and MEL has failed to find any collections which match the syntypes held at K and MEL. *Opercularia hispidula* has been commonly mistaken for *O. hirsuta*, which has led to overestimations of the range and population size of *O. hirsuta*. Because this species has not been

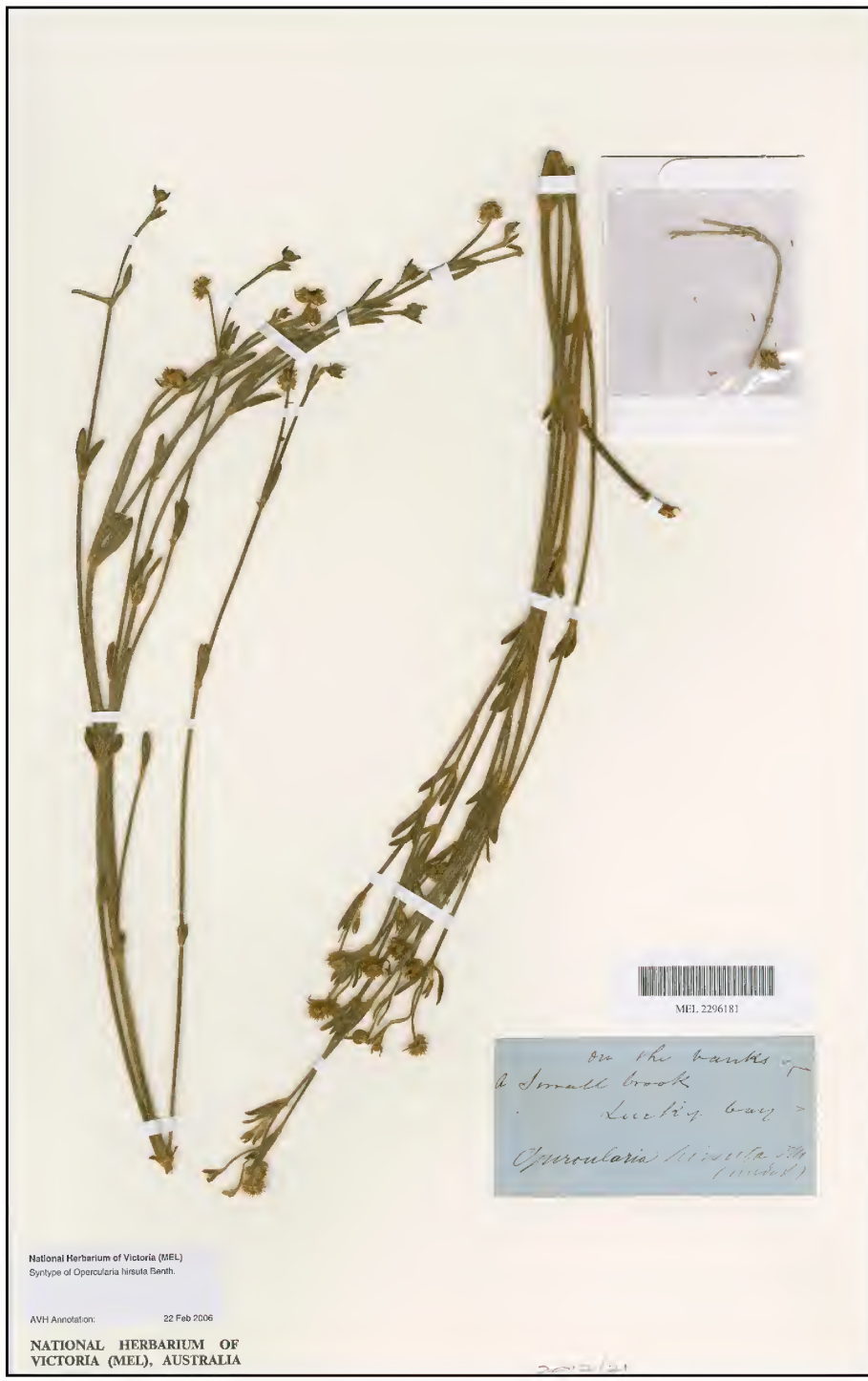

Figure 5. Syntype of *Opercularia hirsuta* (*G. Maxwell s.n.*; MEL 2296181). Reproduced with permission from the National Herbarium of Victoria (MEL), at the Royal Botanic Gardens Victoria.

Figure 6. *Opercularia hirsuta*. A – detail of erect stems showing villose indumentum and elongate peduncles subtending compound capitula; B – capitulum with florets in female phase with exserted styles; C – compound capitulum in male phase showing barely exserted anthers; D – capsiconum showing dense indumentum and detached operculum from one of the capsular syncarpia (insert); E – detail of male phase floret showing anthers and corolla; F – detail of leaves; G – detail of interpetiolar stipule and stem; H – detail of stem and leaves. Scale bars = 10 mm (A, H, F), 5 mm (D, G), 2 mm (B, C), 1 mm (E). Images from *G. Maxwell s.n.* (MEL 2296181). Reproduced with permission from the National Herbarium of Victoria (MEL), at the Royal Botanic Gardens Victoria. Photographs by A. Markey.

recollected since the original 1863 expedition of Maxwell along the south coast, it is possible that *O. hirsuta* is rare and threatened, perhaps even extinct. It is a species requiring both further field survey and examination of other herbarium collections to assess its conservation status.

Similar species. Many of the collections previously identified as *O. hirsuta* at PERTH were actually *O. hispidula*. Most of these misidentified collections were the coastal or granite outcrop ecotypes

with coriaceous and densely hirsute to villous leaves (Figure 7). The crucial difference between these two taxa is the length, shape and position of the peduncle. *Opercularia hirsuta* has an elongate, erect peduncle and sessile, linear or narrowly obovate leaves with acute to obtuse apices (Figures 5, 6), whereas *O. hispidula* has a short, pendulous and recurved peduncle and distinctly petiolate, narrowly obovate to obovate leaves with acute or acuminate apices (Figure 7). Both species have brown, rugulose to rugose, bisulcate seeds lacking an elaisosome, but the seeds of *O. hirsuta* are flecked with white, and narrowly obovate to narrowly elliptic, whereas those of *O. hispidula* are obovate- to elliptic, markedly rugose and uniformly light brown (Figure 1). The two species can share a similar habit, although subshrubs of *O. hispidula* vary from prostrate and compact to few-branched, erect and flexuose.

The vernacular name of this species is Silky-haired Stinkweed.

Opercularia nubicola A.S.Markey, *sp. nov.*

Type: Stirling Range National Park, Western Australia [precise locality withheld for conservation reasons], 1 March 2015, *A. Markey & S. Dillon* SR 9653 (*holo*: PERTH 08772754; *iso*: CANB, MEL).

Opercularia sp. Stirling Range (M. Hislop 2839), Western Australian Herbarium, in *FloraBase* https://florabase.dpaw.wa.gov.au/ [accessed 2 June 2017].

[*Opercularia rubioides auct. non* Juss.: G. Bentham, *Fl. Austral.* 3: 435 (1867).]

An erect, tufted, leafy perennial *herb* or *subshrub c.* 30–60 cm tall. *Stems* erect, wiry, branches arising from stout, short, woody base, young stems glabrous (occasionally scabrous), minutely sulcate, resinous, older stems becoming brown and scarious; indumentum of both papillae and short, stiff hairs, these 0.1–0.3 mm long, conical, uncinate or straight, ascending or adpressed. *Leaves* opposite-decussate, connate at interpetiolar stipule and oriented parallel to stem, sessile to very shortly petiolate; petiole 0–1.5 mm long; lamina 12–26 mm long, 4–6 mm wide, concolorous, bright green, narrowly ovate, coriaceous, rigid, distinctly scabridulous or scabrous adaxially, surface becoming resinous, abaxial surface glabrous; apex acute with prominently rigid tip; margins entire, thickened, scabridulous or scabrous and minutely recurved (particularly on dry material); lateral veins several, raised on abaxial surface and visible on adaxial surface. *Stipules* fused into an interpetiolar stipule, glabrous to (less frequently) sparsely scabrous, stipule margins often sparsely ciliate with stiff, ascending hairs, green, fleshy with 1–2(–3) triangular lobes. *Inflorescence* a spherical compound capitulum of 2–4 (usually 3) fused capitula, often subtended by several involucral bracts, each capitulum with 3–5 fused florets, 10–20(–25) florets per compound capitulum, compound capitulum 7–10 mm diam. *Peduncles* short and recurved or nearly sessile on both terminal and axillary capitula, 1.5–4.0(–7.0) mm long. *Flowers* bisexual, connate on a common receptacle. *Calyx* narrowly triangular, glabrous or minutely scabrous on margins, lacking hairs, persistent on fruit; lobes 3–5, 3–5 mm long in flower, 1.5–3.0 mm long in fruit, linear to narrowly triangular with acute apex. *Corolla* urceolate in female phase, becoming tubular with anther exsertion, 3.0–3.5 mm long; tube 1–2 mm long; lobes 4, 0.8–1.0 mm long with obtuse to acute apices, glabrous. *Stamens* 4; filaments inserted at base of corolla, 3.5–4.5 mm with 1–2 mm exserted from the corolla; anthers yellow or blue, (1.0–)1.5–2.0 mm long, longitudinally dehiscent, dorsifixed. *Ovary* inferior, glabrous, uniloculate or biloculate with one ovule aborted, fused to ovaries of adjacent flowers. *Style* deeply bifurcate, purple, papillose, 5 mm long with 2.5 mm exserted from the corolla. *Fruit* a globular capsiconum of 2–4 syncarpia, each individual syncarpium capsular and dehiscing by an operculum, 7–9 mm diam., glabrous to scabrous, not subtended by bracts.

Figure 7. Features of *Opercularia hispidula*. A – erect stems *in situ* showing sparse indumentum and short, decurved peduncles subtending capitula in a few-flowered form (Porongurup National Park); B – coastal ecotype *in situ* with thick, broad leaves (Cape Le Grand National Park); C – compound capitulum in male phase showing distinctly exserted anthers; D – compound capitulum in female phase showing long-exserted styles; E – detail of interpetiolar stipule and stem; F – immature capsiconum; G – dehisced capsiconum, showing star-shaped cavity remaining after loss of operculum and seeds. Scale bars = 5 mm (C), 3 mm (E, F), 2 mm (D, G). Photographs by A. Markey.

Seeds 1.3–2.0 mm long, 0.6–0.8 mm wide, 0.5–0.7 mm high, obovate to elliptical, trigonous, dark brown flecked with white, rugulose, sometimes cristate on dorsal face, with a keel formed between two broad furrows on ventral face and flanked on either side by an elaiosome. (Figures 1, 8)

Diagnostic features. Distinguished from other Western Australian species by the combination of markedly sessile or near-sessile, narrowly ovate, rigid, coriaceous leaves, tapering to an acute apex with a rigid, pointed tip, rugulose obovate to elliptical seed with a pair of elaiosomes bordering a ventral keel bordered by two broad furrows.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 18 Oct. 1994, *S. Barrett* 47 (PERTH); 6 Dec. 1994, *S. Barrett* 141 (PERTH); 7 July 1985, *E.J. Croxford* 4312 B (PERTH); 1849, J. Drummond 435 (MEL, P); 20 Oct. 2002, *M.* Hislop 2839 (PERTH); 1 Mar. 2015, A.S. Markey & S. Dillon SR 9654–9656 (all PERTH); 12 Mar. 2015, D.A. Rathbone DAR 991 (PERTH).

Phenology. Flowering July–November (peaking around October), with mature capitula shedding seed from February–March.

Distribution and habitat. Restricted to the quartzite peaks of the Stirling Range in southern Western Australia (Figure 4), where it grows in shallow brown loams on rocky substrates, including rock cervices, vertical surfaces and beneath overhangs (Figure 8). Growing in open heath and low *Eucalyptus* woodland. Associated species: *Kunzea montana*, *Acacia drummondii*, *Hakea florida*, *Banksia formosa*, *Nemcia rubra*, *Eucalyptus megacarpa*, *Corymbia calophylla*, *Calothamnus montanus* and *Xanthosia rotundifolia*.

Conservation status. *Opercularia nubicola* is listed by Smith and Jones (2018) as Priority Two under Conservation Codes for Western Australian Flora, under the name *O.* sp. Stirling Range (M. Hislop 2839). It has a limited distribution within a single national park and its montane habitat is vulnerable to fire, dieback and both rainfall decline and temperature extremes predicted to occur with climate change (Barrett & Yates 2015).

Etymology. From the Latin *nubicolus* (cloud-dwelling), this species is named after the cloudy, montane habitat in which it resides, and is inspired by the Noongar name for the Stirling Range, *Koi Kyenunu-ruff*, which describes mountain peaks enshrouded in rolling mist.

Affinities. There are no other species of *Opercularia* in Western Australia that are closely allied to *O. nubicola*. Although greatly disjunct from eastern Australian, it is closely allied to *O. aspera* by its scabrous, coriaceous leaves and overall seed and capitulum morphology. *Opercularia aspera* is a highly variable entity comprised of forms that were originally described as separate taxa by Gaertner (1788), Young (1797), Jussieu (1804) and Sprengel (1825), which were later synonymised or reduced to varietal status by Bentham (1867) (see notes below on *O. rubioides*). Following careful examination, a combination of characters were identified which distinguished *O. nubicola* from *O. aspera s. lat.*, as follows (also presented in Table 1 for clarity). *Opercularia nubicola* is distinguished from *O. aspera* by the combination of sessile to very shortly petiolate leaves, shortly scabrous or scabrous indumentum on adaxial leaf surfaces only, glabrous abaxial leaf surfaces, glabrous or minutely scabrous calyces on the capsiconum, longer and broader calyx lobes, fewer capitula per compound capitulum, fewer florets per compound capitulum, and longer capitulum bracts.

Figure 8. *Opercularia nubicola*. A – fruiting plant, *in situ* on fractured bedrock displaying the erect, subshrub growth habit; B – stems, showing coriaceous, sessile leaves; C – inflorescences on dried specimen, showing globular, flowering, compound capitula; D – mature capsiconum on a short peduncle; E – leaf adaxial leaf surface showing scabrous surface; F –interpetiolar leaf stipule, showing bifurcation into two lobes capped by apical denticles. Scale bars = 10 mm (D), 2 mm (E, F). Images from *A.S. Markey & S. Dillon* SR 9653 (A), *A.S. Markey & S. Dillon* SR 9656 (B, D–F) and *M. Hislop* 2839 (C). Photographs by A. Markey (A, B, D–F) and S. Dillon (C).

Similar species. Sometimes confused with *O. volubilis*, *O. nubicola* can be distinguished by its erect, shrubby habit, coriaceous, scabrous leaves with a distinctive sandpapery texture, whereas *O. volubilis* is a glabrous climber or twining shrub with smooth, relatively thin leaves. The stipules of *O. volubilis* are flexuose, two-lobed and decurved from the node as opposed to being erect and adpressed to the stem in *O. nubicola*. *Opercularia nubicola* can also be confused with *O. hispidula* (Figure 7), the latter species having soft, thin leaves and distinctly hirsute, pilose or villous leaves, flowers and stems, as opposed to the scabrous, coriaceous and distinctly acute, rigid-tipped leaves of *O. nubicola* (Figure 8). *Opercularia echinocephala* may also be mistaken for *O. nubicola*, but this species has a distinctly hispid or setose indumentum composed of longer (>0.5 mm) hairs. Differences in seed morphology among Western Australian species are illustrated in Figure 1. Both *O. volubilis* and *O. apicifolia* Juss. have a single elaiosome covering the ventral keel, whereas both *O. nubicola* and *O. echinocephala* have the elaiosome on either side of this ventral keel. The seeds of *O. hispidula* are lighter brown, distinctly rugose, lacking an elaiosome, shorter in length and more elliptic in shape than for *O. nubicola*.

The suggested vernacular name is Stirling Range Stinkweed.

Table 1. Comparison of morphological traits between *Opercularia nubicola* and *O. aspera s. lat.*

Character	*O. nubicola*	*O. aspera s. lat.*
Calyx lobes lengths (mm)	3–5 in flower 1.5–3.0 in fruit	1.5–2.7 in flower (0.6–)1.0–2.5(–3.0) in fruit
Calyx lobe and involucral bract (if present) shape and position relative to florets	Long and broad. Noticeably longer than the corolla. Characteristically enclosing and extending beyond the florets	Short and narrow. Not enclosing or extending beyond florets
Counts of individual capitula / capsular syncarpia per compound capitulum / capsiconum	2–4 (usually 3)	5–7
Florets per compound capitulum	10–20(–25)	20–35(–40)
Leaf shape	Narrowly ovate, apex acute	Narrowly ovate, ovate or elliptic, apex acute, mucronate or mucronulate
Stem and leaf indumentum	Consistently scabrous on leaves. Usually glabrous stems and glabrous stipules with hairs on margins, but these can be shortly scabrous or scabrous	Ranging from glabrous, scabrous, strigose to densely hispid on leaves, stems and stipules
Petiole presence / length	Leaves consistently near-sessile or sessile (petiole 0–1.5 mm)	Leaves ranging from sessile or near-sessile (petiole 0.5(–1.0) mm) to distinctly petiolate (petiole 2–5 mm)
Calyx and fruiting capitulum indumentum	Usually glabrous, occasionally sparsely scabrous (hairs mostly restricted to the calyx margins)	Can be glabrous (as observed in the 1770 Banks and Solander collections from Port Jackson) but are more commonly scabrous or hispid, often densely so
Hair lengths and shape	Hairs are short (0.1–0.3 mm), stiff, conical, curved or straight	Hairs range from short (0.1–0.3 mm) to longer (0.5–0.7 mm), and vary in shape from flattened and triangular to pointed, conical, curved or straight

Species excluded from Western Australia

Opercularia aspera Gaertn., *Fruct. Sem. Pl.* 1: 112, t. 24, Fig. 4 (1788). *Type*: 'Ex herbario Banksiano, Habitat in Neo-Selandia'. (*syn*: MEL 2268202!, MEL 2268203!, MEL 2268204!, P 03980241 image!, P 03980244 image!, P 03981519 image!, BM 001040395 image!).

Opercularia hyssopifolia Juss., *Ann. Mus. Natl. Hist. Nat.* 4: 428, t. 71, Fig. 1 (1804). *Opercularia aspera* var. *hyssopifolia* (Juss.) Benth., *Fl. Austral.* 3: 434 (1867). *Type*: 'In Australasiâ. Car. ex siccâ vix fructiferâ quam a D. Née acceptam communicavit D. Thibaud.' (*syn*: MPU 014131 image!).

Opercularia ligustrifolia Juss., *Ann. Mus. Natl. Hist. Nat.* 4: 428, t. 71, Fig. 2 (1804). *Opercularia aspera* var. *ligustrifolia* (Juss.) Benth., *Fl. Austral.* 3: 434 (1867). *Type*: 'Car. ex siccâ fructifera ab eodem D. Thibaud communicatâ.' (*syn*: ? P 03911644 image!).

Opercularia rubioides Juss., *Ann. Mus. Natl. Hist. Nat.* 4: 428 (1804), *syn. nov. Type citation*: 'In Australasiâ. Car. ex siccâ in Musaei herbaris nuperrimè observatâ et ideò non delineatâ.' *Type specimen*: Port Jackson, Nouvelle Hollande Côte orientale, [1802], *Baudin expedition* 40 (*lecto*, here designated: P 03981579 image!; *syn*: G-DC G00667896 image!).

Notes. *Opercularia rubioides* was first recognised as occurring in Western Australia by Bentham (1867: 435), who referred a collection by James Drummond (5th Coll., *n.* 435) to this species, noting that it 'accords better with Jussieu's character, especially as the sessile leaves, than any of the forms of *O. aspera*'. Bentham considered *O. rubioides* restricted to Western Australia, a notion that has been followed to the present day (Western Australian Herbarium 1998–; CHAH 2006–); however, this circumscription is at odds with the type gathering of *O. rubioides*, which was collected in south-eastern Australia.

Jussieu's herbarium and types are at the Muséum National d'Histoire Naturelle (P; Stafleu & Cowan 1979: 477–478). Although Jussieu (1804) described *O. rubioides* from material held at the time at P, he did not specifically cite any specimens, only indicating that the distribution was in Australasia. Following examination of collection images via the P *Catalogue of Herbarium specimens*, it appears that the only specimens of *O. rubioides* and allied species available to Jussieu in or prior to 1804 were the collections of Banks and Solander, the Née collections from Thibaud's herbarium and those collected on Baudin's 1801–1804 expedition aboard *Le Naturaliste* and *Le Géographe*. Baudin's expedition stayed in Port Jackson (Sydney) from May–November 1802 (Duyker 2006; George 2009) after exploring parts of the coastline of Australia and Timor. The first allotment of material collected on this expedition was dispatched from Port Jackson in November 1802 on board *Le Naturaliste*, including eastern Australian collections of the *O. aspera* alliance, arriving in Paris in June 1803 (Duyker 2006). Later collections from the expedition's further travels, including a second exploration of the southern Western Australian coastline, arrived in Paris in March 1804 with the return of the remainder of the expedition aboard *Le Géographe* and *Le Casuarina* (Duyker 2006). This second allotment was most likely too late for inclusion in Jussieu's December 1804 publication. Among the collections annotated as *O. rubioides* currently held at P of a suitable date and location to possibly be the type for *O. rubioides* is the sheet P 03981579 (only scans available online have been seen by author). The writing affixed to the sheet, which appears to be that of Leschenault, indicates that it was collected from 'Port Jackson' and the pre-printed label indicates it was collected on the eastern coast of New Holland by the Baudin Expedition in 1801 [1802] (Jangoux 2010). Consequently the sheet P 03981579 cited above is considered to be type material of *O. rubioides*. De Candolle (1830) states that he was sent material of this species from P and refers to its occurrence in eastern Australia. There is a presumed extant duplicate of the type in de Candolle's herbarium at Geneva (G-DC G 00667896); the P specimen has been chosen as the lectotype because it has the strongest provenance.

The type of *O. rubioides* has been determined here as referable to the earlier-named *O. aspera*, a widespread and variable species from Queensland, New South Wales and Victoria (James & Allen 1992; Jeanes 1999; CHAH 2006–). *Opercularia rubioides* is therefore treated as a synonym of *O. aspera* and should be removed from Western Australia's vascular plant census and from the *Threatened and Priority Flora list for Western Australia* (Smith & Jones 2018).

Because *O. nubicola* is restricted to an inland mountain range in southern Western Australia, it was not encountered until the 1840s when it was first collected by Drummond (5th Coll., *n.* 435) and misapplied to *O. rubioides* by Bentham (1867). With the exception of *Drummond* n. 435, Western Australian collections previously identified as *O. rubioides* have been found to be referable to either *O. acolytantha*, *O. vaginata* or *O. echinocephala*. However, several PERTH collections (previously unidentified or misidentified as *O. volubilis*) are a close match to Drummond's collection and Bentham's description of *O. rubioides*, all of which come from a limited area in the uplands of the Stirling Range in far south-western Western Australia. Although the exact location is absent from his specimen, Drummond is also known to have collected in the Stirling Range as part of his 5th Collection (Barker 2005; Maslin & George 2005). These collections are attributable to *O. nubicola*.

Opercularia scabrida Schltdl., *Linnea* 20: 604 (1847). *Type specimen*: An steinigen Orten in Scrubgegenden, South Australia , '90', 1844–1845, *H.H. Behr s.n.* (*holo*: HAL 0098342).

Although *O. scabrida* is currently listed in the Western Australian plant census (Western Australian Herbarium 1998–), Bentham (1867) noted this species was restricted to eastern Australia. Because no collections held at PERTH have ever been identified as *O. scabrida*, nor match either its description (Bentham 1867; Toelken 1986; Jeanes 1999) or representative accessions loaned from the eastern States, it is considered here as absent from Western Australia. Examination of two Western Australian collections identified as *O. scabrida* and held at MEL found these to be either *O. spermacocea* Juss. (MEL 2267542), *O. vaginata* (MEL 2267542) or *O. acolytantha* (MEL 2267541). Specimens collected by R. Helms on the Elder Exploring Expedition and identified as *O. scabrida* (albeit with a note of shorter peduncles than usual) in the expedition report (Mueller & Tate 1896) are apparently the basis of the Western Australian record for this species. The individual mounted on the top left of MEL 2267542 is referable to *O. spermacocea* while the individual mounted on the bottom left of the sheet is referable to *O. vaginata*.

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References

Anon. (1863). Journal of an expedition to Point Culver, in the Australian Bight. *The Inquirer and Commercial News*, Wednesday 23 September 1863, p. 3. https://trove.nla.gov.au/newspaper/article/66013713 [accessed 8 February 2018].

Barker, R. (2005). James Drummond's plant collections today – a global dispersal. *In*: Davies, S.J.J.F. (ed.) *The Drummond Symposium: A review of the work of James Drummond, the first Government Botanist in Western Australia.* Symposium held at Toodyay, Western Australia, by the Toodyay Naturalist's Club, August 27th 2004. *Curtin University of Technology, Department of Environmental Biology Bulletin* no. 27. pp. 40–57.

Barrett, S. & Yates, C.J. (2015). Risks to a mountain summit ecosystem with endemic biota in southwestern Australia. *Austral Ecology* 40: 423–432.

Bentham, G. (1867). *Flora Australiensis.* Vol. 3. (Reeve and Co.: London.)

Berg, R.Y. (1975). Myrmecochorous plants in Australia and their dispersal by ants. *Australian Journal of Botany* 23: 475–508.

Blackall, W.E. & Grieve, B.J. (1982). *How to know Western Australian wildflowers (2nd edition).* Part IV. (University of Western Australia Press: Nedlands, Western Australia.)

Botanical Museum Berlin-Dahlem (2010). *List of families including extant collections of the Botanical Museum Berlin-Dahlem (B) from the time before 1943*. http://www.bgbm.fu-berlin.de/BGBM/research/colls/herb/phanerog.htm [accessed 15 November 2012].

Brown, A., Thomson-Dans, C. & Marchant, N. (1998). *Western Australia's Threatened flora*. (Department of Conservation and Land Management: Como, Western Australia.)

Candolle, A.P. de (1830). *Prodromus systematis naturalis regni vegetabile*. Vol. 4. p. 616. (Treuttel & Würz: Paris.)

Council of Heads of Australasian Herbaria (2006–). *National Species List*. Available on https://biodiversity.org.au/nsl/services/ [accessed September 2017].

Craig, G.F. & Coates, D.J. (2001). *Declared rare and poorly known flora in the Esperance district*. Wildlife Management Program No. 21. Report to Department of Environment and Conservation. (Department of Environment and Conservation: Kensington, Western Australia.)

Department of the Environment and Energy (2018). Threatened Species and Ecological Communities, EPBC Act (1999) List of Threatened Flora. http://www.environment.gov.au/cgi-bin/sprat/public/publicthreatenedlist.pl?wanted=flora [accessed 8 February 2018].

Diels, F.L.E. & Pritzel, E. (1904–5). Fragmenta Phytographiae Australiae occidentalis: Beiträge zur Kenntnis der Pflanzen Westaustraliens, ihrer Verbreitung und ihrer Lebens-Verhältnisse. *Botanische Jahrbucher fur Systematik* 35: 293.

Duyker, E. (2006). *François Péron–An impetuous life: naturalist and voyager*. (Miegunyah Press: Carlton, Victoria.)

Gaertner, J. (1788). *De fructibus et seminibus plantarum*. Vol. 1. (Typis Academiae Carolinae: Stuttgart.)

George, A.S. (2009). *Australian botanist's companion*. (Four Gables Press: Kardinya, Western Australia.)

Hewson, H.J. (1988). *Plant indumentum: a handbook of terminology*. (Australian Government Publishing Service: Canberra.)

Hopper, S.D., van Leeuwen, S., Brown, A.P. & Patrick, S.J. (1990). *Western Australia's Endangered Flora and other plants under consideration for declaration*. (Department of Conservation and Land Management: Wanneroo, Western Australia.)

James, T.A. & Allen, W.K. (1992). *Opercularia*. *In*: Harden, G.J. (ed.) *Flora of New South Wales*. Vol. 3. pp. 490–492. (New South Wales University Press: Kensington, New South Wales.)

Jangoux, M. (2010). The herbarium of the *Terres Australes* (Baudin Expedition, 1800–1804). http://sydney.edu.au/arts/research/baudin/pdfs/herbarium/H0-Introduction-Baudin%20herbarium.pdf [accessed 12 February 2018].

Jeanes, J.A. (1999). Rubiaceae. *In*: Walsh, N.G. & Entwisle, T.J. (eds) *Flora of Victoria. Vol. 4, Cornaceae to Asteraceae*. pp. 616–642. (Inkata Press: Melbourne.)

Jussieu A.-L. de (1804). Mémoire sur l'*Opercularia*, genre de plantes voisin de la famille des Dipsacées. *Annales du Muséum National d'Histoire Naturelle* 4: 416–428.

Keighery, G.J. (1999). A new species of *Opercularia* (Rubiaceae) from Western Australia. *Nuytsia* 13(1): 29–32.

Lengyel, S., Aaron, D., Gove, A.D., Latimer, A.M., Majer, J.D. & Dunn, R.R. (2009). Ants sow the seeds of global diversification in flowering plants. *PLoS ONE* 4(5): e5480. doi:10.1371/journal.pone.0005480.

Markey, A.S. (2012). *A targeted spring flora survey of New Island Bay, Cape Le Grand National Park*. Unpublished report prepared for Tourism Branch, Department of Environment and Conservation. (Department of Environment and Conservation: Kensington, Western Australia.)

Maslin, B.R. & George, A.S. (2005). James Drummond's collections from south-west Western Australia. *In*: Davies, S.J.J.F. (ed.) *The Drummond Symposium: a review of the work of James Drummond, the first Government Botanist in Western Australia*. Symposium held at Toodyay, Western Australia, by the Toodyay Naturalist's Club, August 27th 2004. *Curtin University of Technology, Department of Environmental Biology Bulletin* no. 27. pp. 34–39.

Mueller, F.J.H. von (1863–4). *Fragmenta phytographiae Australiae*. Vol 4. (Government Printer: Melbourne.)

Mueller, F.J.H. von & Tate, R. (1896). Phanerogams and vascular cryptogams. *Transactions of the Royal Society of South Australia* 16(3): 333–383.

Orchard, A.E. (1999). A history of systematic botany in Australia. *In*: Orchard, A.E. (ed.) *Flora of Australia*. Vol. 1 (2nd edn.). pp 11–103. (Australian Biological Resources Study: Canberra.)

Smith, M.G. (2018). *Wildlife Conservation (Rare Flora) Notice 2017. Summary of additions, deletions and changes to the notice as of 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/images/documents/plants-animals/threatened-species/Listings/summary_of_changes_to_rare_flora_notice.pdf [accessed 8 February 2018].

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 8 February 2018].

Sprengel, A. (1825). *Opercularia*. *In*: Sprengel, K. *Caroli Linnaei - Systema Vegetabilium*. Vol. 1. (16th edn.) p. 385. (Librariae Dietrichianae: Gottingae [Göttingen].)

Spjut, R.W. (1994). A systematic treatment of fruit types. *Memoirs of the New York Botanical Garden* 70: 1–182.

Stafleu, F.A. & Cowan, R.S. (1979). *Taxonomic literature: a selective guide to botanical publications and collections with dates, commentaries and types*. Vol. 2. (Bohn, Scheltema and Holkema: Utrecht.)

Rye, B.L. (1987). Rubiaceae. *In*: Marchant, N.G., Wheeler, J.R., Rye, B.L., Bennett, E.M., Lander, N.S. & Macfarlane, T.D. (eds) *Flora of the Perth region.* Part 2. pp. 643–646. (Western Australian Herbarium, Department of Agriculture: [Kensington,] Western Australia.)

Toelken, H.R. (1986). Rubiaceae. *In*: Jessop, J.P. & Toelken, H.R. (eds) *Flora of South Australia. Part II, Leguminosae-Rubiaceae*. pp. 1059–1076. (South Australian Government Printing Division: Adelaide.)

Walter, K.S. & Gillett, H.J. (eds) (1998). *1997 IUCN Red List of Threatened Plants.* Compiled by the World Conservation Monitoring Centre. (IUCN–The World Conservation Union: Gland, Switzerland and Cambridge, UK.)

Wheeler, J.R. (2002). Rubiaceae. *In*: Wheeler, J., Marchant N. & Lewington, M. (eds) *Flora of the south west: Bunbury-Augusta-Denmark.* Vol. 2. pp. 864–867. (Australian Biological Resources Study: Canberra.)

Western Australian Herbarium (1998–). *FloraBase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. https://florabase.dpaw.wa.gov.au/ [accessed 14 March 2018].

Western Australian Minister for the Environment (2015). Wildlife Conservation (Rare Flora) Notice 2015. *Western Australian Government Gazette* 166: 3rd November 2015.

Young, T. (1797). Description of a new species of *Opercularia*. *Transactions of the Linnean Society of London* 3: 30–32.

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SHORT COMMUNICATION

Tecticornia willisii (Chenopodiaceae), a new samphire from the Little Sandy Desert in Western Australia

Tecticornia willisii K.A.Sheph., *sp. nov.*

Type: Little Sandy Desert, Western Australia [precise locality withheld for conservation reasons], 16 August 2001, *K.A. Shepherd & S. van Leeuwen et al.* KS 829 (*holo*: PERTH 08592284; *iso*: CANB, MEL).

Tecticornia sp. Little Sandy Desert (K.A. Shepherd & C. Wilkins KS 830), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 20 January 2018].

Perennial shrub to 0.5–1 m high. *Vegetative articles* obovoid, cylindrical or narrowly obconic, dull green to red, 1.2–2.5(3.5) mm long, 1.1–2.3 mm wide, epidermis rough, apex apiculate, margin denticulate. *Inflorescence* 2.7–7 mm long, 1.2–2.4 mm wide, with single bisexual florets at the base of each bract forming a spike 2–6 nodes long, terminal to main or lateral branches, cylindrical, with a gently sinuate outline due to slight lateral compression of the bracts. *Bracts* obovoid, fused, upper edge straight to gently curved, appearing shallowly convex in face view and shallowly concave in side view, outer face of bract slightly rounded, epidermis rough, apex apiculate, margin denticulate. *Flowers* obscured or apex slightly exposed above subtending bracts, free from bracts below, slightly embedded in bract above. *Perianth* fused, dorsiventrally flattened, adaxial surface shallowly to steeply ascending, abaxial surface steeply ascending, apex apiculate, margin denticulate; two lateral lobes. *Stamen* 1, anther oblong, 0.7–0.9 mm long. *Ovary* free from the stem cortex, style bifid, membranous. *Fruiting spike* scarcely expanded, papery. Apical vegetative growth absent. *Fruitlets* hidden or the apex exposed above subtending bracts, somewhat fused to bracts above and below; fruiting perianth scarcely expanded and similar in shape to flowering perianth, papery, fused with the pericarp. *Pericarp* membranous enclosing the seed, not dehiscing in the medial plane. *Seed* horizontal to shallowly ascending relative to the stem axis, rounded, 0.6–0.8 mm long, beak small to 0.1 mm long, opaque, very brown to dark reddish brown with concentric rings of fused mammilate projections on the outer margin, sides granular. (Figure 1)

Diagnostic characters. Distinguished from other species of *Tecticornia* Hook.f. by the following combination of characters: erect subshrub to shrub; single florets in the axil of each bract; vegetative articles and bracts with a denticulate margin, apiculate apex and a distinctive rough epidermis; and 'Type 3' seed coat ornamentation (Shepherd *et al.* 2005).

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 16 Aug. 2001, *K.A. Shepherd & C. Wilkins* KS 830 (AD, NSW, PERTH); 17 Aug. 2001, *K.A. Shepherd & S. van Leeuwen et al.* KS 857 (PERTH); 21 Oct. 1996, *S. van Leeuwen* 2948 (PERTH); 14 Oct. 2017, *G. Wells* LSCR01-01 (PERTH); 14 Oct. 2017, *G. Wells* LSCT01Q03-01 (PERTH); 14 Oct. 2017, *G. Wells* LSCT01Q04-01 (PERTH); 14 Oct. 2017, *G. Wells* LSCT01Q06-01(PERTH).

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Figure 1. *Tecticornia willisii*. A – forming the dominant vegetation along the shore line of a salt lake in the Little Sandy Desert; B – habit; C – branchlets highlighting the rough epidermis of the vegetative articles. Images by G. Wells from *G. Wells* LSCT01Q03-01.

Phenology. The duration of flowering is not clear but flowers at anthesis are evident on specimens collected from August and October. Fruits appear to develop from late spring and are likely held on the plant through summer.

Distribution and habitat. *Tecticornia willisii* is endemic to the Little Sandy Desert bioregion of the Eremaean Botanical Province. It grows in seasonally inundated areas around the margins of gypsiferous playas and salt lakes or, as observed at one site, across the entire playa of a small lake. This species is found in red, brown and white sandy clay over calcrete and gypsum associated with *Tecticornia* spp. and *Maireana luehmannii* shrubland and isolated pockets of *Eragrostis dielsii*.

Conservation status. Currently listed as Priority One under Conservation Codes for Western Australian Flora (Smith & Jones 2018), under the name *T.* sp. Little Sandy Desert (K.A. Shepherd & C. Wilkins KS 830). There are only a few documented populations of this species, none of which are found within the conservation estate. Current threats include grazing by camels, and wildfire. Mineral exploration activity has also increased in the region in recent years due to interests in mining gypsum and potash, which may pose a threat to populations in the future.

Etymology. This species is named for my husband Spencer Robert Willis (1968–). Spencer has supported me in all things (as he said he would) and whilst he may not appreciate this recognition due to his own

unassuming nature, he is a worthy recipient of this honour. Spencer has often volunteered to undertake fieldwork with me during his holidays, usually working under hot and difficult conditions to collect samphires around arid salt lakes. He has also contributed to research on the family Goodeniaceae by driving field vehicles, collecting specimens and taking detailed floral photographs utilised in our floral morphometrics research (Gardner *et al.* 2016a, 2016b; Berger *et al.* 2017).

Vernacular name. Spencer's Samphire.

Affinities. Phylogenetic analyses of molecular data supports *T. willisii* as distinct and most closely related to *T.* sp. Sunshine Lake (K.A. Shepherd et al. KS 867) based on nuclear ribosomal DNA (nrDNA) internal transcribed spacer (ITS) sequences (Shepherd *et al.* 2004), and *T. fimbriata* (Paul G.Wilson) K.A.Sheph. & Paul G.Wilson based on a more recent analysis using both ITS and external transcribed spacer (ETS) data (N. Dakin unpub. data). *Tecticornia* sp. Sunshine Lake is also a Priority One species from the Great Sandy Desert, Little Sandy Desert and Murchison bioregions (Western Australian Herbarium 1998–; Smith & Jones 2018), which sometimes co-occurs with *T. willisii*. It is easily recognised as distinct from it, having 3-flowered cymes rather than single flowers, articles and bracts that have a smooth epidermis (vs rough) and entire margins (vs denticulate), and smooth, golden brown seeds (vs dark brown ornamented seeds). *Tecticornia* fimbriata is a Priority Three species (Smith & Jones 2018) that occurs further south in the Avon Wheatbelt and Murchison bioregions (Western Australian Herbarium 1998–). Like *T. willisii*, this species has a rough epidermis and apiculate articles and bracts; however, it differs in having 3-flowered cymes, article margins that are fimbriate and seeds with a 'Type 1' ornamentation of small rounded bumps (vs 'Type 3'), as determined in Shepherd *et al.* (2005).

Tecticornia papillata K.A.Sheph., a Priority One species (Smith & Jones 2018) restricted to a small area in the Gascoyne bioregion (Western Australian Herbarium 1998–), also has a rough epidermis but this species has 3-flowered andromonoecious cymes, where each central floret is bisexual and the two lateral florets are male. The seeds of this species are smooth and golden brown (Shepherd 2008).

Notes. This rather nondescript new species was discovered more than 20 years ago during Department of Conservation and Land Management targeted surveys of the south-western Little Sandy Desert (National Reserve System Project N706) (van Leeuwen 2002). Recent material was collected during ongoing surveys by Dr Grant Wells (Phoenix Environmental Sciences), which facilitated the description of this species.

Galls of various shapes and size are frequently found on samphires, which are caused by gall midges (Veenstra *et al.* 2011). A number of grey, globular galls 3–4 mm diam. are present on the lower branches of various collections of *T. willisii*.

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References

Berger, B.A., Han, J., Sessa, E.B., Gardner, A.G., Shepherd, K.A., Ricigliano, V.A., Jabaily, R.S. & Howarth, D.G. (2017). The unexpected depths of genome-skimming data: A case study examining Goodeniaceae floral symmetry genes. *Applications in Plant Sciences* 5(10): 1700042.

Gardner, A.G., Fitzgerald, J.N., Menz, J., Shepherd, K.A., Howarth, D.G. & Jabaily, R.S. (2016a). Characterizing floral symmetry in the Core Goodeniaceae with geometric morphometrics. *PLoS ONE* 11(5): e0154736. doi:10.1371/journal.

Gardner, A.G., Sessa, E.B., Michener, P., Johnson, E., Shepherd, K.A., Howarth, D.G. & Jabaily, R.S. (2016b). Utilizing next-generation sequencing to resolve the backbone of the Core Goodeniaceae and inform future taxonomic and floral form studies. *Molecular Phylogenetics and Evolution* 94: 605–617.

Shepherd, K.A. (2008). *Tecticornia papillata* (Chenopodiaceae: Salicornioideae), a new andromonoecious samphire from near the Carnarvon Range, Western Australia. *Nuytsia* 18: 259–266.

Shepherd, K.A., Colmer, T.D. & Macfarlane, T.D. (2005). Morphology, anatomy and histochemistry of fruits and seeds of the Salicornioideae (Chenopodiaceae). *Annals of Botany* 95: 917–933.

Shepherd, K.A., Waycott, M. & Calladine, A. (2004). Radiation of the Australian Salicornioideae (Chenopodiaceae) – based on evidence from Nuclear and Chloroplast DNA sequences. *American Journal of Botany* 91: 1387–1397.

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 24 January 2017].

Western Australian Herbarium (1998–). *FloraBase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. https://florabase.dpaw.wa.gov.au/ [accessed 27 March 2018].

van Leeuwen, S. (2002). Biological survey of the south-western Little Sandy Desert: National Reserve System Project N709: final report, June 2002. (Department of Conservation and Land Management: Western Australia.)

Veenstra, A.A., Michalczyk, A. & Kolesik, P. (2011). Taxonomy of two new species of gall midge (Diptera: Cecidomyiidae) infesting *Tecticornia arbuscula* (Salicornioideae: Chenopodiaceae) in Australian saltmarshes. *Australian Journal of Entomology* 50(4): 393–404.

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SHORT COMMUNICATION

Ptilotus actinocladus (Amaranthaceae), a new and rare species from the Gascoyne bioregion, Western Australia

Ptilotus R.Br. (Amaranthaceae) is a genus of approximately 110 species, all of which are native to continental Australia and with most of the diversity occurring in Western Australia (Bean 2008; Hammer *et al.* 2015). During the construction of a comprehensive identification key to the genus for *KeyBase* (available at http://keybase.rbg.vic.gov.au/keys/show/6609), specimens identified as *P. pseudohelipteroides* Benl in Western Australia were found to be inconsistent with the morphology of *P. pseudohelipteroides* from eastern Australia, leading to the erection of the phrase name *P.* sp. Doolgunna (D. Edinger 4419). This short communication presents the result of an investigation into the taxonomic status of that phrase name, the new species *P. actinocladus* T.Hammer & R.W.Davis.

Ptilotus actinocladus T.Hammer & R.W.Davis, *sp. nov.*

Type: Doolgunna Station, Western Australia [precise locality withheld for conservation reasons], 5 August 2003, *G. Byrne* 307 (*holo*: PERTH 06592813).

Ptilotus sp. Doolgunna (D. Edinger 4419), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 25 October 2017].

Prostrate *annual herbs* to 10 cm high, 25 cm wide. *Stems* terete, ribbed, glabrescent, with a persistent tuft of nodose hairs at the base of leaves and buds; a central stem ascending to *c.* 2(–10) cm long, particularly when young, with radiating prostrate lateral stems to 18 cm long, becoming numerous with age. *Basal leaves* not seen. *Cauline leaves* linear-lanceolate to oblanceolate, 4–22 mm long, 0.5–3 mm wide, glabrescent or with sparse nodose hairs; apex mucronate, mucro 0.25–0.50 mm long. *Inflorescences* terminal, spiciform, globular to cylindrical, 5–15 mm long, 11–14 mm wide, pink. *Bracts* ovate, 3.0–3.3 mm long, 1.4–1.8 mm wide, transparent, glabrous; apex mucronate, mucro 0.2–0.3 mm long. *Bracteoles* broadly ovate, 3.0–3.5 mm long, 1.9–2.0 mm wide, transparent, glabrous; apex mucronate, mucro 0.1–0.2 mm long. *Outer tepals* narrowly lanceolate, 4.5–4.9 mm long, 0.9–1.2 mm wide; apex margins in-rolled, truncate to shortly tapering, serrated; outer surface with long, silky, nodose hairs to 1.5 mm long, apex glabrous. *Inner tepals* narrowly lanceolate, 4.1–4.7 mm long, 0.5–0.8 mm wide; apex margins in-rolled, acute, not serrated; outer surface with long, silky, nodose hairs to 1.5 mm long, apex glabrous. *Fertile stamens* 4; *filaments* 1.4–1.6 mm long, uneven, dilated towards the base; *anthers* 0.4–0.5 mm long, 0.15–0.20 mm wide, pink. *Staminode* 2.3–2.5 mm long, sinuate. *Staminal cup* 0.3–0.5 mm long, oblique, lobed. *Staminal cup appendages* alternating with staminal filaments, 0.5–0.6 mm long, 0.2–0.3 mm wide, transparent, with sparse hairs on both surfaces; apex truncate, serrate; those appendages adjacent to the staminode are basally adnate to it, with acute apices. *Ovary* obconical, 1.2–1.5 mm long, 0.8–1.0 mm wide, apically villous; stipe 0.1–0.2 mm long. *Style* slightly curved, 1.1–1.3 mm long, slightly excentric on the ovary apex. *Stigma* capitate. *Seed* round, light brown, *c.* 1.5 mm long, *c.* 0.9 mm wide. (Figures 1A, 2A)

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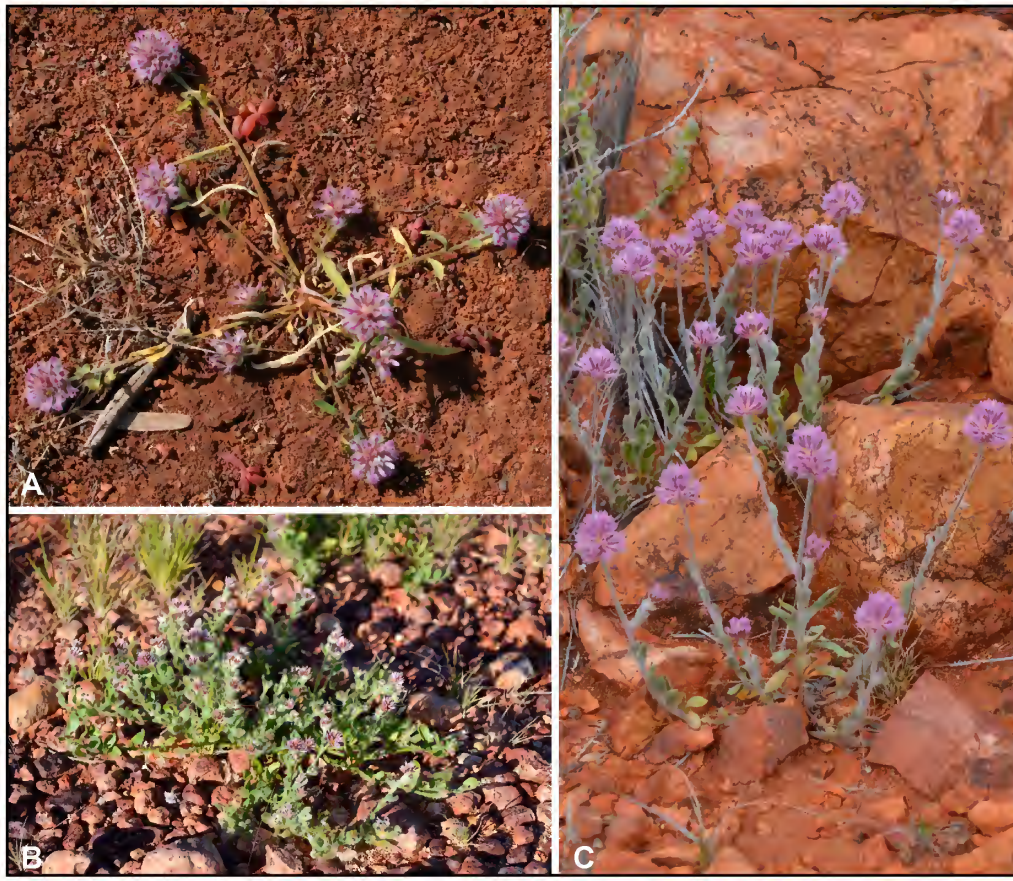

Figure 1. Comparative morphology of plants *in situ*, highlighting differences in habit and leaf form. A – *Ptilotus actinocladus* (*G. Byrne* 2759); B – *P. pseudohelipteroides* (*T. Hammer & K. Thiele* TH 91); C – *P. helipteroides* (*R. Davis, T. Hammer & B. Anderson* RD 12266). Photographs by G. Byrne (A) and T. Hammer (B, C).

Diagnostic features. *Ptilotus actinocladus* may be distinguished from all other members of the genus by the following combination of characters: a prostrate annual herb with glabrescent stems and leaves, glabrous and translucent bracts, pink flowers, tepals <10 mm long, 4 fertile stamens, 1 staminode 2.3–2.5 mm long, staminal cup appendages (pseudostaminodes) 0.5–0.6 mm long, an excentric style placed on the ovary summit, and an apically hairy ovary.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 14 July 2007, *G. Byrne* 2759 (PERTH); 13 July 2004, *D. Edinger* 4419 (PERTH); 15 July 2004, *D. Edinger* 4423 (PERTH); 4 Nov. 1965, *D.W. Goodall* 3267 (PERTH); 24 Aug. 1973, *E. Wittwer* 1137 (PERTH).

Phenology. Flowering collections have been made from July to November.

Distribution and habitat. *Ptilotus actinocladus* has been collected from Doolgunna Station, Woodlands Station and Belele Station in Western Australia (Figure 3), with only a single collection known from each of the latter two locations, from 1973 and 1965, respectively. The habitat has been described as flat, seasonally inundated plains with sparse vegetation.

Figure 2. Longitudinal section of dissected flowers in late bud. A – *Ptilotus actinocladus* (*G. Byrne* 2759); B – *P. pseudohelipteroides* (*T. Hammer & K. Thiele* TH 91); C – *P. helipteroides* (*R. Meissner & Y. Caruso* 561). Scale bar = 1 mm.

Conservation status. *Ptilotus actinocladus* is listed by Smith and Jones (2018) as Priority One under Conservation Codes for Western Australian Flora, under the name *P.* sp. Doolgunna (D. Edinger 4419). Given that this species is only represented in recent specimens from near Doolgunna Station, we consider this species to be rare and of conservation concern.

Etymology. The epithet derives from the Greek *aktis* (a ray or beam) and *klados* (a branch or stem), referring to the radiating, prostrate flowering stems, sometimes becoming numerous, which are characteristic of this species (Figure 1A).

Taxonomic notes. The new species can be easily distinguished from *P. helipteroides* (F.Muell.) F.Muell., with which it overlaps in distribution, by its distinctly radiating, prostrate flowering stems, whereas *P. helipteroides* is erect (rarely decumbent) and can reach >60 cm high (Figure 1). The habit of *P. pseudohelipteroides* is bushy (quite noticeable on many specimens), and it has a persistent indumentum covering the stems and leaves; the flowering stems are often closely clustered. This is quite different from *P. actinocladus*, in which all flowering stems (except the young apical shoot) are prostrate (flush with the ground). *Ptilotus actinocladus* can be further distinguished from *P. pseudohelipteroides* by the shape of the staminal cup appendages, which are basally adnate (rising

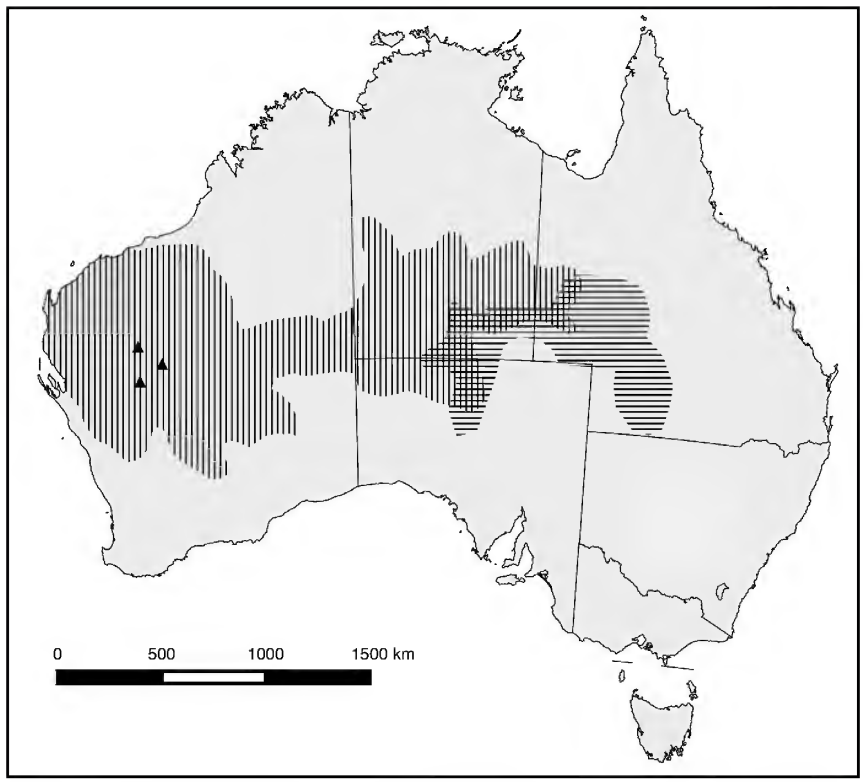

Figure 3. The distributions of *Ptilotus actinocladus* (triangles) and *P. helipteroides* (vertical shading) and *P. pseudohelipteroides* (horizontal shading) as inferred from records retrieved from the Australasian Virtual Herbarium (http://avh.chah.org.au/).

above the rest of the staminal cup) to the staminode and have acute apices in both *P. actinocladus* and *P. helipteroides*. In *P. pseudohelipteroides*, the staminal cup appendages are not adnate to the base of the staminode and have a rounded, or sometimes flattened, shape (see Benl 1959). *Ptilotus helipteroides* can be distinguished from both *P. actinocladus* and *P. pseudohelipteroides* by having larger anthers and longer staminal filaments, staminode, style and tepals than either of the two other species, which are similar in the sizes of the floral parts (Figure 2).

The type of *P. actinocladus* (PERTH 06592813) has been previously sequenced for the phylogeny of the genus as *P. pseudohelipteroides* (GenBank accessions: KP875954 for ITS and KP875857 for *matK*; Hammer *et al.* 2015). In that phylogeny, this species was placed as sister to *P. helipteroides*. The true *P. pseudohelipteroides* (from central and eastern Australia; see Figure 3) was not included, but presumably it would sit with the other two on the molecular phylogeny. These species together with *P. gaudichaudii* (Steud.) J.M.Black, *P. eremita* (S.Moore) T.Hammer & R.W.Davis (previously *P. gaudichaudii* subsp. *eremita* (S.Moore) Lally) and *P. modestus* T.Hammer (previously *P. gaudichaudii* subsp. *parviflorus* (Benth.) Lally) form a highly supported clade (>99% in all analyses; Hammer *et al.* 2015). This clade shares a noteworthy synapomorphy in the development of the fruit. After anthesis, the persistent tepals, enclosing the ovary and seed, harden considerably and pinch inward above the ovary base to form a tight, indurated covering around the fruit, and the tepal apicies flex outward and gape widely. The hardened tepal bases may provide some limited protection for the seed, while the gaping, papery, persistent tepals most likely aid in wind dispersal (see Hammer *et al.* 2018).

Ptilotus gaudichaudii, *P. eremita* and *P. modestus* can be easily distinguished from the new species by lacking staminal cup appendages and having green or yellow tepals with abaxial hairs restricted to the midline.

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The authors acknowledge the directors and staff of the Western Australian Herbarium (PERTH) and the State Herbarium of South Australia (AD) for providing access to their collections and helpful assistance. We would also like to acknowledge Geoff Byrne for permission to use his photograph of the new species. T.A. Hammer acknowledges the support of a Forrest Research Foundation PhD scholarship and University Postgraduate Award (UWA).

References

Bean, A.R. (2008). A synopsis of *Ptilotus* (Amaranthaceae) in eastern Australia. *Telopea* 12(2): 227–250.

Benl, G. (1959). New species and varieties of *Ptilotus* R.Br. (Amaranthaceae). *Muelleria* 1(2): 102–108.

Hammer, T., Davis, R. & Thiele, K. (2015). A molecular framework phylogeny for *Ptilotus* (Amaranthaceae): Evidence for the rapid diversification of an arid Australian genus. *Taxon* 64(2): 272–285.

Hammer, T.A., Davis, R.W. & Thiele, K.R. (2018). The showy and the shy: Reinstatement of two species from *Ptilotus gaudichaudii* (Amaranthaceae). *Australian Systematic Botany* 31(1): 1–7. https://doi.org/10.1071/SB17026.

Smith M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 27 March 2018].

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SHORT COMMUNICATION

Two new species of *Hibbertia* (Dilleniaceae) from Western Australia

Two new species of *Hibbertia* Andrews (Dilleniaceae) have been resolved among collections in the Western Australian Herbarium during an assessment of material previously included in a broadly circumscribed *H. helianthemoides* (Turcz.) F.Muell. Both had previously been included in an informal taxon segregated as *H.* sp. Geraldton Sandplains (R. Edmiston E 421); they belong in *Hibbertia* subgen. *Hibbertia*, but are probably not closely related.

Hibbertia pubens K.R.Thiele, *sp. nov.*

Type: 1.2 km west of the Brand Highway on Cooljarloo Road, *c.* 8 km direct line north-west of Cataby, Western Australia, 10 December 2017, *K.R. Thiele* 5448 (*holo*: PERTH 08926158; *iso*: AD, CANB, MEL).

Low *shrubs* 0.2–0.3(–0.45) m high, the stems erect at first, later sprawling, resprouting from a stout taproot after fire; branchlets with a moderate to dense indumentum of fine, white, curled, simple hairs sometimes overlain by longer, straighter ones; older stems with pale brown, papery bark decorticating in strips. *Leaves* spreading, scattered or clustered at the apices of short-shoots, linear, (10–)15–25(–35) mm long, (1.3–)2–4(–5) mm wide, the margins distinctly but usually loosely recurved and not obscuring the undersurface, the midrib moderately thickened abaxially; adaxial surface smooth, tardily glabrescent, with sparse to moderate, white, curled to flexuose, simple hairs 0.4–0.8 mm long when young, denser and straighter on the margins towards the leaf base; abaxial surface persistently pubescent with moderate to dense, white, curled, simple hairs to 0.2 mm long, the midrib with longer, straighter hairs like the adaxial surface; apex obtuse. *Flowers* sessile, solitary or few-clustered at the ends of short-shoots, closely subtended by the upper leaves; flower-subtending bract herbaceous, linear to narrowly oblong, 3–7 mm long, obtuse, with indumentum as for the leaves. *Sepals* 5, broadly ovate, slightly attenuate to a blunt apex, 7–9 mm long, abaxially moderately to densely pubescent with short, white, curled to flexuose, simple hairs, adaxially glabrous; midribs not prominent; outer and inner sepals similar in size, apex shape and indumentum but the inner ones broader and with glabrous margins. *Petals* 5, yellow, broadly obovate, 9–12 mm long, obscurely emarginate. *Stamens* (15–)18–25(–39), in 5 bundles around the gynoecium, usually with 3 or 6 stamens per bundle (sometimes as few as 2 or as many as 10); most stamens fused by their filaments as far as the anther, the innermost usually free almost to the base; filament bundles *c.* 1.5 mm long; anthers rectangular, *c.* 2 mm long, dehiscing by introrse, longitudinal slits. *Staminodes* absent. *Carpels* 3; ovaries compressed-globular, glabrous; styles spreading excentrically from the carpel apex, *c.* 3.5 mm long. *Ovule* 1 per carpel. *Fruiting carpels* and seeds not seen.

Diagnostic features. *Hibbertia pubens* may be distinguished from all other Western Australian taxa by its combination of stamens in 5 bundles united by their filaments and surrounding the 3 glabrous carpels, and linear to narrowly elliptic leaves with loosely recurved margins and an abaxial indumentum of short, white, curled hairs.

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Other specimens examined. WESTERN AUSTRALIA: 15 km SE of Eneabba, 20 Oct. 1979, *R.J. Cranfield s.n.* (PERTH); 15 km SE of Eneabba, 23 May 1980, *R.J. Cranfield* 1445 (PERTH); 26 km W of Badgingarra, 18 Dec. 1995, *R. Davis* 423 (PERTH); 300 m along Woolka Road from junction with Brand Highway, *c.* 9 km N of Cataby, 2 Dec. 2002, *R. Davis* 10542 (PERTH); Alexander Morrison National Park, 22 Nov. 1978, *E.A. Griffin* 1754 (PERTH); 15 km S of Eneabba on Brand Highway, 24 Feb. 1981, *E.A. Griffin & M.I. Blackwell* 2825 A (PERTH); near Mullering Brook, 25 Feb. 1971, *B.R. Maslin s.n.* (PERTH); Rose Thompson Road, E of Eneabba, 14 Nov. 2007, *C. Godden* EM 05-03 (PERTH); near E border of Nambung Nature Reserve, region of Mullering Brook, 29 Nov. 1974, *R. Pullen* 9723 (CANB, PERTH); South Eneabba Nature Reserve, 20 Nov. 2007, *B. Taylor & K. Greenacre* P2-111-02 (PERTH); Cooljarloo Road, N of Cataby, 1 Jan. 2017, *K.R. Thiele* 5420 (PERTH).

Phenology. A late-flowering species, recorded flowering between October and February, probably peaking in late November and early December, with outlying records in May and July.

Distribution and habitat. Distributed between the vicinities of Eneabba and Cataby in the Lesueur Sandplain sub-bioregion of the Geraldton Sandplains IBRA bioregion, mostly along or close to the Brand Highway, with a slightly more easterly collection from Alexander Morrison National Park (Figure 1A). Occurs on white or grey sandplains over laterite, in *Banksia*-dominated kwongan heaths often with *Eucalyptus todtiana* and *E. drummondii*.

Conservation status. Hibbertia pubens is represented in the Western Australian Herbarium by nine specimens distributed in an area *c.* 90 km × 35 km. Some collections are within nature reserves and national parks, while others are on roadsides and adjacent to sand-mining operations. While it is not currently considered to be at risk, much of the area where it occurs has been cleared for agriculture or is prospective for mineral sands. Many *Hibbertia* species, especially lignotuberous ones such as *H. pubens*, are considered 'recalcitrant' in post-mining revegetation projects due to low seed set and strong inhibition of germination (Schatral *et al.* 1997). This species should be considered when assessing impacts of mining operations.

Etymology. The epithet is from the Latin *pubens* (pubescent), in reference to the distinctive indumentum of short, curled hairs on the abaxial leaf surface, which serves to distinguish it from superficially similar taxa.

Affinities. The relatives of *H. pubens* are unknown. It superficially resembles *H. huegelii* (Endl.) F.Muell. *s. str.* (see Thiele 2017), *H. sericosepala* K.R.Thiele and *H. leucocrossa* K.R.Thiele, differing from the first in having loosely rather than tightly recurved leaf margins, from the second in having a sparse, appressed, curled rather than dense, spreading-pilose indumentum on the sepals, and from the last in having sparsely pilose, non-glaucous leaves without a distinct basal fringe. From all three it differs in the distinctive persistent, short, white, curly hairs on the abaxial leaf surface (*cf.* glabrous in the other three species). *Hibbertia desmophylla* (Benth.) F.Muell. may also be related, but that differs in having shorter, distinctly fascicled leaves with a sparse pilose indumentum of more or less straight hairs on the abaxial leaf surface, and usually glabrous sepals.

Notes. Overall indumentum is somewhat variable in many species of *Hibbertia*. In general, juvenile plants and young growth are more hairy than adult plants and mature growth, with elements of the juvenile and/or young-growth indumentum variably persisting. However, the abaxial leaf lamina indumentum appears in many cases to be relatively invariant, and hence is a strong character for species

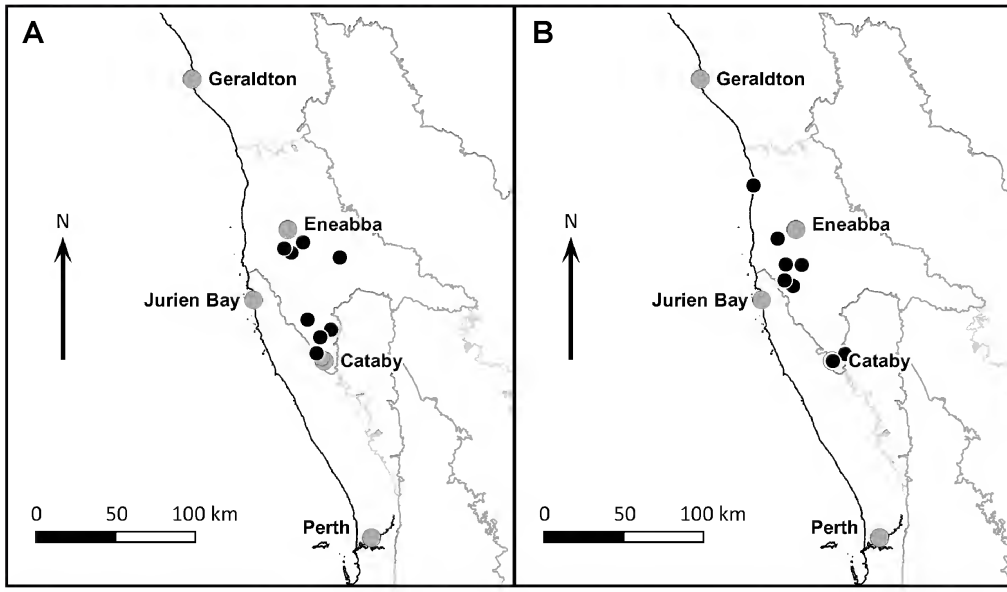

Figure 1. Distribution of A – *Hibbertia pubens* and B – *H. squarrosa* in the Lesueur Sandplain sub-bioregion of the Geraldton Sandplains IBRA bioregion of Western Australia. IBRA7 boundaries (Department of the Environment 2013) shown in grey (bioregions) and light grey (sub-bioregions).

delimitation and identification. In the case of *H. pubens*, the abaxial indumentum is highly consistent, and clearly different from that of superficially similar congeners. Abaxial leaf indumentum also allowed the separation (see Thiele 2009) of the otherwise superficially similar *H. propinqua* K.R.Thiele (abaxial leaf surface sparsely simple-pubescent) from *H. fasciculiflora* K.R.Thiele (densely stellate-pubescent).

Compared with many other species of *Hibbertia*, flowering in *H. pubens* is rather sparse. While flowers are often somewhat clustered at the ends of short-shoots, they appear to open sequentially so that only a relatively small number of flowers are open at any one time, during an extended flowering period.

In the most common stamen arrangement, 24 stamens are arranged in five bundles in a pattern of 3,6,3,6,6. In bundles with three stamens, all filaments are fused as far as the anthers. In bundles with six stamens, the innermost stamen has a filament that is free almost to the base of the bundle while the remainder are fused as far as their anthers. Some flowers have reduced numbers of stamens in each bundle (e.g. 2,4,2,4,3) and lack the free inner stamen on the larger bundles, while others have supernumerary stamens (e.g. 4,7,4,7,7 or 5,9,6,9,10).

Hibbertia squarrosa K.R.Thiele, *sp. nov.*

Type: Coorow-Green Head Road, 13.4 km west of the Brand Highway, Western Australia, 2 July 2016, *K.R. Thiele* 5323 *& R. Davis* (*holo*: PERTH 08812497; *iso*: AD, CANB, MEL).

Hibbertia sp. Geraldton Sandplains (R. Edmiston E 421), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 1 January 2018].

Erect *shrubs* 0.2–0.5 m high, single-stemmed at base; branchlets moderately pubescent with greyish, rather appressed, flexuose, tangled hairs; older stems with reddish-brown, papery bark decorticating in strips. *Leaves* spreading, scattered or ± fasciculate on short-shoots, linear to very narrowly obovate, somewhat dilated at the insertion on the stem (particularly noticeable on flower-subtending leaves), (12–)15–20(–35) mm long, (0.8–)1–2(–3) mm wide, the margins strongly recurved and usually obscuring the undersurface, the midrib abaxially not prominent; adaxial surface smooth, soon or tardily glabrescent, with sparse to moderate, pale grey to white or pale brown, flexuose, ± appressed simple hairs to 1 mm long, denser and straighter on the margins towards the leaf base; abaxial surface as for adaxial; apex obtuse. *Flowers* sessile, solitary or several together terminating short-shoots; flower-subtending bract herbaceous, linear to rectangular with an expanded base, 5–7 mm long, obtuse to subacute, often with a reduced leaf blade, with indumentum as for leaves. *Sepals* 5, broadly triangular to broadly ovate, the outer ones (and usually the inner) with a prominent, thickened, acuminate, ± stiffly recurved apex, 8–11 mm long, abaxially sparsely to moderately pubescent with silky, appressed, crisped to flexuose, white (rarely pale brown) simple hairs to 1.5 mm long, adaxially glabrous; midribs not prominent except for the thickened apex; outer sepals larger, more triangular, and more prominently apically thickened-acuminate than the inner. *Petals* 5, pale yellow, broadly obovate, 9–10 mm long, truncate to broadly emarginate. *Stamens* 20, all around the gynoecium, fused by their filaments into 5 distinct bundles of 4 stamens each, the outer 3 with filaments fused as far as the anthers, the inner one as for the outer or offset by a short, free portion of filament; filament bundles 0.5–1 mm long; anthers broadly rectangular, 1.8–2 mm long, dehiscing by introrse, longitudinal slits. *Staminodes* absent. *Carpels* 5; ovaries compressed-globular, glabrous; styles spreading excentrically from the carpel apex, 1.5–2 mm long. *Ovule* 1 per carpel. *Fruiting carpels* and seeds not seen.

Diagnostic features. *Hibbertia squarrosa* may be distinguished from all other Western Australian taxa by its combination of stamens in 5 bundles each of 4 stamens united by their filaments and surrounding the 5 glabrous carpels, and appressed-pubescent sepals each with a prominent, thickened, squarrose apex.

Other specimens examined. WESTERN AUSTRALIA: Mt Lesueur, *s. dat.*, *Anon.* (PERTH 03073254); *c.* 1.3 km SW of the intersection of Rocky Spring Road and Great Northern Highway [Brand Highway], Eneabba, 15 Sep. 2009, *L. Cockram* RC 076 (AD, PERTH); Cliff Head, Dongara, 20 Sep. 1973, *R. Edmiston* E 421 (PERTH); Bidgerabbie Hill SE of Dandaragan, 28 June 1988, *E.A. Griffin* 4831 (PERTH); Mt Misery, W of Dandaragan, 11 Sep. 1988, *E.A. Griffin* 5035 A (PERTH); farm E of Cataby, 15 Sep. 1988, *E.A. Griffin* 5153 (PERTH); Banovich Road 1.2 km from junction with Jurien East Road, 8 Feb. 2006, *M. Hayes* 461 (PERTH); between Eneabba and Cockleshell Gully, near Kings Homestead, 10 Nov. 1974, *R.D. Hoogland & G.L. Stebbins* 12488 (CANB, L, PERTH, UC); Coorow-Greenhead Road, 13.4 km W of junction with Brand Highway, 10 Sep. 1999, *J.W. Horn* 2368 (DUKE, PERTH).

Phenology. Flowers in late winter and spring, with most records from September to November (one flowering specimen collected in February, and the type collection in flower in July).

Distribution and habitat. Distributed between the vicinities of Dongara and Cataby in the Lesueur Sandplain sub-bioregion of the Geraldton Sandplains IBRA bioregion, mostly on the coastward side of the Brand Highway (Figure 1B). The type collection was made in a distinctive habitat, a lower slope below lateritic uplands on grey sand, with water seepage evident at the time of collection but probably summer-dry, in an open shrubland with *Allocasuarina humilis*, *Xanthorrhoea drummondii*, *Synaphaea spinulosa*, *Acacia pulchella*, *Hakea incrassata* and *Hibbertia hypericoides* subsp. *septentrionalis*. The collecting notes for three other specimens (*M. Hayes* 461, *E.A. Griffin* 5035 A, *E.A. Griffin* 5153) describe a similar soil and landform, while others mention 'white sand' and 'sandy lateritic gravel,

upland', with vegetation mostly described as kwongan heath beneath low, open *Eucalyptus todtiana* and *E. drummondii*; one specimen was collected in *E. wandoo* forest.

Conservation status. *Hibbertia squarrosa* is known from an area *c.* 150 × 25 km, including from nature reserves and national parks. Substantial areas of natural vegetation remain within this range, although its required habitat may not be common. While it is not currently considered to be at risk, further clearing of its habitat for mineral sand mining or agriculture could pose a future threat.

Etymology. The epithet is from the Latin *squarrosus* (rough with stiff scales), in reference to the characteristically relatively rigid and divergent sepals in late bud and after anthesis.

Affinities. *Hibbertia squarrosa* is most similar to, and is probably closely related to, *H. glabrisepala* J.R.Wheeler, sharing with that species a similar androecium and somewhat squarrose sepals; *H. glabrisepala* differs in having glabrous leaves and sepals, more distinctly widened leaf bases, and larger, more prominent and broader bracts surrounding the base of the calyx. In *H. glabrisepala* the uppermost leaves are progressively reduced, losing their lamina and widening and grading into the bracts. In *H. squarrosa* this is less obvious, and the bracts are narrower and less prominent. Leaves in *H. glabrisepala* are also usually shorter and narrower than those in *H. squarrosa*.

The northernmost specimen, *R. Edmiston* E 421, has a pale brown indumentum throughout, but is otherwise typical.

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References

Department of the Environment (2013). *Australia's bioregions (IBRA)*, IBRA7, Commonwealth of Australia. http://www.environment.gov.au/land/nrs/science/ibra#ibra [accessed 24 November 2017].

Schatral, A., Osborne, J.M. & Fox, J.E.D. (1997). Dormancy in seeds of *Hibbertia cuneiformis* and *H. huegelii* (Dilleniaceae). *Australian Journal of Botany* 45(6): 1045–1053.

Thiele, K.R. (2009). Three new species of *Hibbertia* (Dilleniaceae) from Western Australia. *Nuytsia* 19(2): 283–293.

Thiele, K.R. (2017). *Hibbertia striata*, a new name for a long-overlooked Western Australian species, and the taxonomic resolution of *H. pachyrrhiza* and *H. huegelii*. *Nuytsia* 28: 247–253.

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SHORT COMMUNICATION

Ptilotus yapukaratja (Amaranthaceae), a new species from the Gascoyne bioregion of Western Australia

Ptilotus yapukaratja R.W.Davis & T.Hammer, *sp. nov.*

Type: Lorna Glen, Western Australia, 16 June 2017, *K. Millet* 346 (*holo*: PERTH 08904618; *iso*: CANB, MEL).

Low, compact, woody, perennial *shrubs* to 30 cm high, 35 cm wide. *Stems* terete, glabrescent, with moderately dense, ascending, sub-verticillate hairs to 0.3 mm long. *Basal leaves* absent. *Cauline leaves* scattered, incurved, narrowly oblanceolate, boat-shaped in cross section, fasciculate at dwarf stem shoots, 4–10 mm long, 0.9–1.5mm wide, with ascending, sparse, stiff, sub-verticillate hairs to 0.2 mm long; apex mucronate. *Inflorescences* spiciform, terminal, solitary, pink, ovoid, 20–32 mm long, 28–32 mm diam., 15–25 flowers per inflorescence. *Bracts* translucent, pink along midrib, 5.7–6.7 mm long, ovate, with verticillate hairs becoming glabrous towards margins; midrib prominent. *Bracteoles* translucent, pink along midrib, 4.8–5.9 mm long, broadly ovate, with verticillate hairs along central portion; midrib prominent. *Flowers* curved slightly upwards. *Outer tepals* pink fading white towards the base, narrowly oblanceolate, concave, flattening towards the apex, 13–14 mm long; outer surface hairy except at the apex, with dense, appressed to slightly spreading, sub-verticillate hairs to 3 mm long; inner surface glabrous; apex shortly tapering, entire. *Inner tepals* pink fading white towards base, narrowly oblanceolate, concave, 12–13 mm long; outer surface hairy except at the apex with dense, appressed to ascending, sub-verticillate hairs to 2 mm long; inner surface glabrous except for a basal tuft of tangled sub-verticillate hairs on the margins; apex centrally folded, attenuate, entire. *Staminal cup* symmetrical, 1.2–1.5 mm long, with sub-verticillate hairs to 1 mm long. *Stamens* 2; filaments glabrous, straight, dilating towards base, 6.5–7.8 mm long; *anthers* 0.5–0.7 mm long. *Staminodes* 3, 0.9–1.1 mm long. *Ovary* ellipsoid, gibbous, 2.9–3.1 mm long, 1.6–1.8 mm wide, with a row of verticillate hairs across the summit; *stipe* terete, 0.7–0.9 mm long. *Style* straight to slightly sinuate, excentrically fixed to ovary, 7.7–8 mm long, with verticillate hairs on the basal portion. *Seed* glossy, brown, 1.9–2.1 mm long. (Figure 1)

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 22 Oct. 2013, *M. Griffiths & S. Cherriman s.n.* (PERTH); 17 Feb. 2016, *J. Jackson & V. Jackson* 330 (PERTH); 17 Feb. 2016, *J. Jackson & V. Jackson* 331 (PERTH).

Diagnostic features. *Ptilotus yapukaratja* can be distinguished from all other *Ptilotus* R.Br. species by the following combination of characters: a rigid habit, glabrous incurved leaves, bracts longer than bracteoles, two fertile stamens, an excentrically placed style on the ovary, and a hairy ovary.

Phenology. The new species is only known from two flowering and fruiting collections made from the same locality, one made in October and the other in June. This would suggest flowering times are in response to random rain events.

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Figure 1. *Ptilotus yapukaratja*. A – plant *in situ*, showing habit and habitat; B – a close-up showing an inflorescence with an open flower. Images by K. Millet from *K. Millet* 346.

Distribution and habitat. Currently only known from north of Lorna Glen Station, where it is found at the base of breakaways on shallow rocky slopes in open scrub on brown clayey-sandy soils.

Conservation status. To be listed as Priority One under Conservation Codes for Western Australian Flora (M. Smith pers. comm.). *Ptilotus yapukaratja* is only known from the one remote location north of Lorna Glen Station.

Etymology. The epithet derives from the Matuwa words *yapu* (rock) and *karatja* (belonging to), referring to the rocky habitat where the species occurs (see Figure 1A).

Affinities. The new species is clearly aligned with the *P. parvifolius* (F.Muell.) F.Muell. complex (subclade D2 in Hammer *et al.* 2015), and it is morphologically most similar to *P. rigidus* Lally and *P. daphne* Lally (see Lally 2009). It differs from *P. rigidus* in having narrowly oblanceolate leaves 4–10 mm long (*cf.* narrowly obovate, 2.5–5.5 mm long) and longer bracts (5.7–6.7 mm long vs 4.5–5.2 mm long); it varies from *P. daphne* in having much longer bracts (5.7–6.7 mm long vs 3–4.5 mm long), many more flowers per inflorescence (15–25 vs 7–10), pink tepals fading white towards base (*cf.* purple throughout), and a row of hairs along the ovary summit (*cf.* hairy ovary throughout). It could also be confused with the morphologically similar *P. polakii* F.Muell. subsp. *polakii*; however, it differs from this taxon in having incurved leaves and an ellipsoid, gibbous and hairy ovary (*cf.* straight leaves and an obovoid, glabrous ovary).

Ptilotus yapukaratja has had its ITS (nrDNA) and *matK* (cpDNA) markers sequenced for a forthcoming PhD thesis on the molecular systematics of the genus (Hammer in prep.), and is most similar in its nucleotide sequence to *P. disparilis* Lally and *P. fasciculatus* W.Fitzg. (which are also members of subclade D2). Unlike the new species, *P. fasciculatus* is a prostrate perennial herb that occurs on the margins of salt lakes in the Geraldton Sandplains, Avon Wheatbelt and Mallee bioregions of Western Australia. *Ptilotus disparilis* differs from the new species in having tepals less than 6.5 mm long with dense, wavy hairs at the apex and is endemic to South Australia (Lally 2008). Also included in a forthcoming molecular study were *P. rigidus* and *P. daphne*, which were resolved in the same clade as the new species, but despite their morphological similarity, they were found to be more varied in the nucleotide sequence (in ITS and *matK*) than the new species. This suggests that the new species can be distinguished in both morphological and molecular characters.

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We thank Simon Cherriman and Mike Griffiths who first discovered this taxon, Jennifer Jackson who facilitated further field observations, and Ken Millet who photographed and made the type collection. Also, Jo Palmer and Barbara Rye contributed to the improvement of the manuscript. We acknowledge Elders from the Tarlka Matuwa Piarku Aboriginal Corporation, the traditional custodians of the Matuwa Kurrara Kurrara Indigenous Protected Area for their contribution to the name of the new taxon. TAH acknowledges the support of the Forrest Research Foundation PhD Scholarship.

References

Hammer, T., Davis, R.W. & Thiele, K.R. (2015). A molecular framework phylogeny for *Ptilotus* (Amaranthaceae): evidence for rapid diversification of an arid Australian genus. *Taxon* 64 (2): 272–285.

Lally, T.R. (2008). Resolution of the *Ptilotus parvifolius* complex (Amaranthaceae). *Journal of the Adelaide Botanic Gardens* 22: 37–46.

Lally, T.R. (2009). New taxa of *Ptilotus* (Amaranthaceae) from Western Australia. *Nuytsia* 19(1): 53–62.

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A taxonomic revision of species with a petaloid epicalyx bract allied to *Lasiopetalum bracteatum* (Malvaceae: Byttnerioideae)

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Abstract

Shepherd, K.A. & Wilkins, C.F. A taxonomic revision of species with a petaloid epicalyx bract allied to *Lasiopetalum bracteatum* (Malvaceae: Byttnerioideae). *Nuytsia* 29: 161–179 (2018). This treatment focuses on an informal group of six species where *Lasiopetalum bracteatum* (Endl.) Benth., *L. membranaceum* (Steud.) Benth. and *L. molle* Benth. are revised and lectotypified, an updated description of the Threatened species *L. rotundifolium* Paust is provided, and two new related species of conservation concern, *L. decoratum* K.A.Sheph. & C.F.Wilkins and *L. rupicola* K.A.Sheph. & C.F.Wilkins, are newly described. Images and distribution maps are included.

Introduction

Taxonomic research on the Western Australian species of the genus *Lasiopetalum* Sm. (subf. Byttnerioideae Burnett, Malvaceae) is ongoing (Shepherd & Wilkins 2015, 2017) and the recent publication of an interim key, which includes a number of potentially new but as yet unnamed taxa (Shepherd & Wilkins 2018), highlights more work yet to be done on this charismatic group. This treatment is another in the series, focusing on an informal group allied to *L. bracteatum* (Endl.) Benth. (the *L. bracteatum* group), characterised by fan-shaped hairs along most of the length of the style and a large, petaloid epicalyx bract usually positioned some distance from the base of the calyx. Updated descriptions are provided for *L. bracteatum*, *L. membranaceum* (Steud.) Benth., *L. molle* Benth. and *L. rotundifolium* Paust, and two new species are described herein as *L. decoratum* K.A.Sheph. & C.F.Wilkins and *L. rupicola* K.A.Sheph. & C.F.Wilkins. These species were respectively known under the informal phrase names *L.* sp. Badgingarra (E.A. Griffin 5278) and *L.* sp. Hill River (T.N. Stoate 5) and both are listed as taxa of conservation concern. As *L. rupicola* is currently only known from a single population on private property it may warrant recognition as a Threatened species.

Methods

This study was based on the examination of field collections, spirit material and herbarium specimens lodged at PERTH or loaned from other Australian institutions. The description of the indumentum and density of hairs follows Shepherd and Wilkins (2017). Leaf descriptions and measurements are

https://florabase.dpaw.wa.gov.au/nuytsia/
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based on mature leaves unless otherwise stated. Seed measurements are not provided for *L. rupicola* and *L. molle* as only immature seeds were available for examination. Images of type material were viewed via *Global Plants* (https://plants.jstor.org/).

Taxonomy

The *L. bracteatum* group can be recognised by the following combination of characters: mature *stems* red-brown, glabrescent; *leaves* narrowly ovate to broadly ovate, or orbicular, with the base slightly to deeply cordate; *stipules* absent; *inflorescence* a dichasial cyme; *epicalyx bract* single, stalked, petaloid, ovate, usually distant from the flower-base (Figure 1C); *calyx* pink-mauve, without prominent ribs, usually with the inner base dark red or dark red and green; *petals* absent, *staminal* tube and *staminodes* absent; *anthers* 5, deep red, ovate with an obtuse apex, glabrous, with introrse dehiscence of white pollen from apical pores; *style* filiform with dense, white, reflexed, fan-shaped, stellate hairs along most of its length; *ovary* 3-carpellate with 2 ovules per carpel; *fruit* a loculicidal capsule.

For a key to the species in the *L. bracteatum* group see Shepherd and Wilkins (2018).

Lasiopetalum bracteatum (Endl.) Benth., *Fl. Austral.* 1: 266 (1863). *Corethrostylis bracteata* Endl. *Nov. Stirp.* Dec. 1: 1 (1839). *Type citation*: '*Crescit in Novae-Hollandiae austro-occidentalis interioribus*. (Röe.) Colitur in horto Hügeliano.' *Type specimen*: 'Hugel [Hügel] n. 71. Baron Hugel cult[ivated] in Vienna from Swan River [Western Australia]' (*lecto*, here designated: K 000686561! [right hand specimen]).

Corethrostylis coriacea Steud. in Lehmann, J.G.C. (ed.) *Pl. Preiss.* 1(2): 236 (1845). *Type citation*: 'In N. Holl. austr. occ. Herb. Preiss. No. 1637.' *Type specimen*: 'In Australia occidentale' [Western Australia], *L. Preiss* 1637 (*lecto*, here designated: LD 1241773!).

Erect, spreading *shrub* 0.6–1.5 m high, 0.4–1 m wide. *Young stems* with a dense indumentum of scattered to moderately dense stalked (to 0.7 mm long) stellate hairs with *c.* 12 arms, each to 1.5 mm long, over moderately dense to dense sessile stellate hairs with *c.* 8 arms, each to 0.2 mm long, with or without moderately dense red-tipped glandular hairs to 0.3 mm long. *Petioles* (4.3–)6–13(–18) mm long, indumentum as for young stems. *Leaves* pliable, ovate, moderately discolorous, (8–)19–45(–66) mm long, (8–)11–30(–46) mm wide, base slightly cordate, apex acute; margins entire to sinuate, scarcely to moderately recurved; abaxial surface with occasional to scattered stalked (*c.* 0.7 mm long) stellate hairs with 6–10 arms, each to 0.8 mm long, over moderately dense to dense stellate hairs with *c.* 8 arms, each 0.3–0.5 mm long, glandular hairs absent; adaxial surface smooth with scattered to moderately dense sessile or occasionally stalked (to 0.7 mm long) stellate hairs with *c.* 6–12 arms, each to 0.5 mm long, glandular hairs absent, glabrescent (sometimes with hair stalks remaining). *Inflorescence* a loose dichasium (often flexuose), 46–80(–98) mm long, with 8–22 flowers. *Peduncles* 10–37(–47) mm long with occasional stalked (to 0.5 mm long) stellate hairs with *c.* 8 arms, each to 1.3 mm long, over moderately dense stellate hairs with *c.* 12 arms, each to 0.15 mm long, and moderately dense red-tipped glandular hairs to 0.7 mm long. *Pedicels* 4.1–7(–9) mm long, indumentum as for peduncles but without the scattered large stellate hairs. *Bract* narrowly elliptic, 2.3–7.2(–12.3) mm long, 0.3–2.6(–5) mm wide. *Epicalyx bract* attachment usually mid-way or towards the pedicel base *c.* 4 mm below the calyx, with a dark pink stalk to 0.3 mm long, blade ovate, mauvish pink, 4–8 mm long, 2–5.8 mm wide; abaxial surface and margin with scattered stalked stellate hairs with *c.* 8 arms, each to 0.3 mm long, with or without occasional glandular hairs to 0.2 mm long; adaxial surface with scattered sessile stellate hairs with *c.* 4–6 arms, each to

0.2 mm long, and occasional glandular hairs to 0.2 mm long towards the base. *Calyx* bright pink to mauvish pink, base dark red without green markings, 4.8–8.3 mm long, with a tube 0.6–1.4 mm long; lobes narrowly ovate, 3.7–7.1 mm long, 2.3–3 mm wide; outer surface with moderately dense white stellate hairs with 8–10 arms, each to 0.2 mm long and moderately dense to dense red-tipped glandular hairs *c.* 1.1 mm long towards the lower 1/3, 0.2 mm long for the remainder; inner surface glabrous towards the base with moderately dense simple hairs or stellate hairs with 1–6 arms, each to 0.15 mm long, towards the apex, glandular hairs absent. *Staminal filaments* 0.4–0.6 mm long. *Anthers* 1.5–1.6 mm long, 0.7–0.9 mm wide. *Ovary* 0.9–1 mm long, 0.9–1 mm wide; outer surface tomentose with stellate hairs to 0.2 mm long, with or without inconspicuous glandular hairs to 0.2 mm long. *Style* 3–4.1 mm long. *Fruit* ellipsoid, 4.1–4.5 mm long, *c.* 3.5 mm wide, with residual moderately dense stellate hairs and scattered glandular hairs to 0.2 mm long. *Seed* ellipsoid, dull blackish tan with small black spots, 2.2–2.4 mm long, 1.4–1.7 mm wide, with moderately dense or occasional stellate hairs; aril a whitish cream cap with 2 long and 3 short arms to mid-length of seed, *c.* 1.5 mm long, *c.* 1.3 mm wide. (Figure 1)

Diagnostic features. Readily distinguished from morphologically allied species by a combination of the following characters: plant aromatic; leaves pliable, ovate, base slightly cordate, apex acute, adaxial surface smooth, both surfaces with a mix of scattered large stellate hairs and moderate to dense small stellate hairs; inflorescence a loose (often flexuose) dichasium up to 98 mm long with 8–22 flowers, peduncles 10–37(–47) mm long.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 27 Oct. 1992, *P. Armstrong* PGA 92004 (PERTH); 14 Jan. 1993, *P. Armstrong* PGA 93002 (PERTH); Oct. 1994, *M. Aylward s.n.* (MEL, PERTH 05466873); 17 Oct. 1978, *R.J. Cranfield* 859 (PERTH); 18 Nov. 1988, *R.J. Cranfield* 7618 (PERTH); 26 Feb. 2009, *A. Crawford* ADC 1986 (K, PERTH); 3 Oct. 1997, *M. Hislop & B.A. Fuhrer* MH 947 (PERTH); 1 Oct. 1999, *F. Hort* 684 (CANB, PERTH); 6 Nov. 2006, *F. Hort* 2932 (AD, CANB, PERTH); 23 Nov. 2010, *F. Hort* 3675 (NSW, PERTH); 28 Sep. 1991, *G.J. Keighery* 13183 (PERTH); 9 Oct. 2005, *B. Koch* BK 10 (PERTH); 6 Nov. 2000, *K. Macey* 274 (PERTH); 26 Nov. 1996, *A. Markey* 752 (PERTH); 8 Oct. 1996, *A. Markey* 1205 (PERTH); 14 Sep. 1992, *S. Patrick* 1210 (PERTH); 1 Oct. 1992, *S. Patrick* SP 1292 A (PERTH); 11 Oct. 2016, *K.A. Shepherd & C.F. Wilkins* KS 1631 (PERTH); Oct. 1959, *L. Steenbohm* 2323 (PERTH); 28 Oct. 1986, *A. Taylor s.n.* (PERTH); 5 Dec. 2004, *C.F. Wilkins* 2098 (PERTH).

Phenology. Flowering observed through spring to early summer from September to November. Fruiting from early summer.

Distribution and habitat. Jarrah Forest and Swan Coastal Plain bioregions of the South West Botanical Province, found on the Darling Scarp east of Perth from Mundaring to Lesmurdie, in the Canning River catchment, and further south in the Dryandra Woodland (Figure 2). This species grows in orange clay-loam or yellow-brown to brown loamy-sand with laterite, often over granite. Plants are frequently found growing in or near creek lines or along the edge of sheet granite in open jarrah and marri forest or woodland over dense heath.

Conservation status. This species is listed by Smith and Jones (2018) as Priority Four under Conservation Codes for Western Australian Flora. While a few populations do occur within the conservation estate, a number of collections are situated near urban areas. These populations in particular may be vulnerable to ongoing development, increased fire frequency and dense weed infestations, and as such, further survey is required to confirm their current status.

Figure 1. *Lasiopetalum bracteatum*. A – habit; B – ovate leaves with a scarcely cordate base and scattered stellate hairs on the adaxial surface; C – a loose dichasial inflorescence covered in stellate hairs and red-tipped glandular hairs with narrowly elliptic bracts (black arrow) and ovate, petaloid epicalyx bracts (white arrow) positioned some distance from the base of the pink flowers. Unvouchered specimens from near Lesmurdie Falls, Lesmurdie. Photographs by K.A. Shepherd.

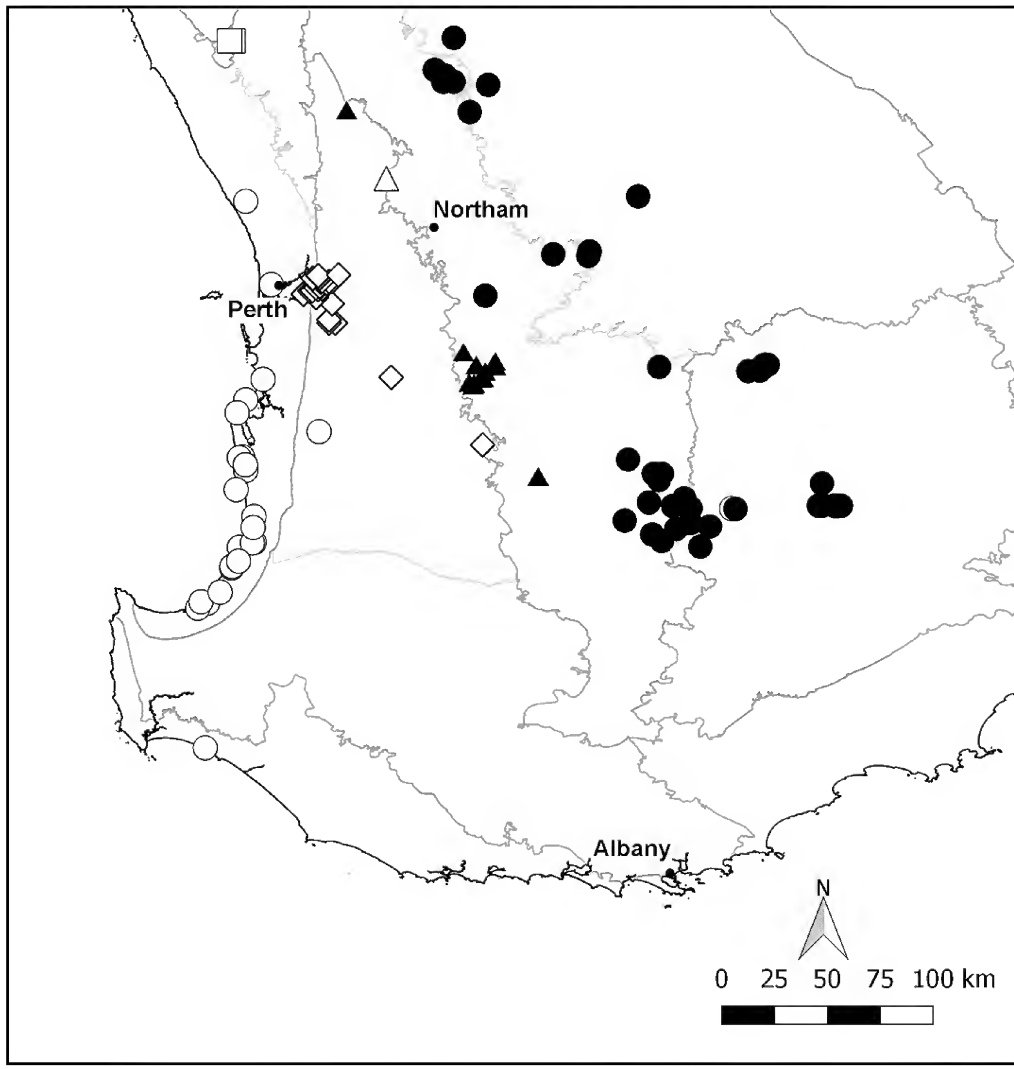

Figure 2. Distribution map of *Lasiopetalum bracteatum* (◇), *L. decoratum* (△), *L. membranaceum* (○), *L. molle* (●), *L. rotundifolium* (▲) and *L. rupicola* (□) in Western Australia, with IBRA regions (Department of the Environment 2013) in grey and subregions in pale grey.

Affinities. *Lasiopetalum bracteatum* is most similar to *L. membranaceum* as both species have pliable, ovate leaves, but it is distinct in being aromatic, the leaves having scattered large stellate hairs and moderate to dense small stellate hairs below (*cf.* scattered to moderately dense large stellate hairs only), and the flowers being bright pink to mauve-pink and dark red at the very base of each calyx lobe (*cf.* mauvish pink calyx with dark red along the centre and base of each lobe) (Figure 1).

Typification. The Hügel specimen on the top right hand side of sheet K 000686561 is a relatively small fragment with a few leaves and two young inflorescences; however, it is still a good match for the protologue. The label on the sheet states the material was cultivated in Hügel's garden in Vienna. There is no indication that this material originally came from J.S. Roe as stated in the type citation. While the type citation refers to a Roe collection from the 'interior of south

western Australia' *L. bracteatum* is generally confined to creek lines on the Darling Scarp just east of Perth, although it has also been collected from Dryandra Woodland to the south. Roe and Hügel did visit the 'upper Swan River', presumably where *L. bracteatum* typically grows, in early December 1833 [incorrectly stated as 1883 in George 2009: 533]. Roe also supplied Hügel with duplicates of his specimens before he left the Swan River Colony (Hercock 2014) but no Roe collections of *L. bracteatum* have been found to date. The two left hand specimens (K 000686560!) on the same sheet are *Drummond* n. 65 collections, which were cited by Bentham in his *Flora Australiensis* treatment but do not constitute type material.

Corethrostylis coriacea was regarded by Steudel (1845) as having the same bracts as Endlicher's *C. bracteata* and indeed Bentham (1863) treated this species as a synonym of *L. bracteatum*. The *Preiss* 1637 collection housed at LD is a relatively small fragment and while there is a possibility of further type material being located, this specimen is readily identified as *L. bracteatum* and matches Steudel's brief description in *Plantae Preissianae*. As such it is designated here as the lectotype for *C. coriacea*.

Lasiopetalum decoratum K.A.Sheph. & C.F.Wilkins, *sp. nov.*

Type: Toodyay, Western Australia [precise locality withheld for conservation reasons], 7 November 2006, *F. Hort* 2926 (*holo*: PERTH 07485980; *iso*: AD, CANB, K, MEL, NSW).

Lasiopetalum sp. Badgingarra (E.A. Griffin 5278), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au [accessed 30 January 2018].

Lasiopetalum molle subsp. *boothendarrense* E.M.Benn. & K.Shepherd ms, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 30 January 2018]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 543 (2000), *nom. inval.*

Erect or spreading *subshrub* or *shrub* (0.2–)0.6–1.5(–2) m high, 0.5–1.7 m wide. *Young stems* tomentose, with scattered sessile or stalked (*c.* 0.5 mm long) stellate hairs with 10–15 arms, each to 0.6–0.8 mm long, over dense sessile stellate hairs with *c.* 12 arms, each to 0.6 mm long, and scattered to dense red-tipped glandular hairs to 1.3 mm long. *Petioles* (5–)9–17 mm long, indumentum as for young stems. *Leaves* thick, stiff, ovate to broadly ovate, rarely scarcely trilobed, discolorous, (5.4–)16.5–28.3 mm long, (7–)14.2–22 mm wide, base slightly cordate, apex acute or rounded-acute; margins entire to sinuate, moderately recurved; abaxial surface densely hairy to tomentose with moderately dense sessile stellate hairs with *c.* 15 arms, each to 0.3 mm long, and with scattered glandular hairs to 0.8 mm long on rib; adaxial surface scarcely rugose, new growth with scattered to moderately dense stalked (*c.* 0.2 mm long) stellate hairs with *c.* 10 arms, each to 0.4 mm long, and scattered glandular hairs to 1 mm long, glabrescent with residual hair stalks. *Inflorescence* a loose dichasium, (21–)35–74 mm long, with 6–12(–18) flowers. *Peduncles* 9.7–17.1 mm long, densely hairy with or without scattered stalked (*c.* 0.15 mm long) stellate hairs with *c.* 12 arms, each to 0.5 mm long, over stellate hairs with *c.* 12 arms, each to 0.4 mm long, and scattered to dense red-tipped glandular hairs, 0.4–1.5 mm long. *Pedicels* 6.2–8.2 mm long, indumentum as for peduncles. *Bract* elliptic, 1.7–4 mm long, 0.8–2.5 mm wide. *Epicalyx bract* attachment on mid- to lower pedicel, 3–5 mm below the calyx, with a dark pink stalk 0.4–1 mm long, blade ovate, mauvish pink, 4.5–8 mm long, 3–7 mm wide; abaxial surface with scattered stalked (to 0.5 mm long), stellate hairs with *c.* 12 arms, each to 0.3 mm long, over scattered stellate hairs with *c.* 12 arms, each to 0.3 mm long, and scattered

glandular hairs to 1 mm long; adaxial surface with scattered stellate hairs with *c.* 6 arms, each to 0.3 mm long, with scattered glandular hairs to 0.3 mm long towards the base. *Calyx* mauvish pink, base dark red without green markings, 5–8.3 mm long, with a tube 1–1.8 mm long; lobes narrowly ovate, spreading to reflexed at peak flowering, 3.7–6.5 mm long, 1.3–2.1 mm wide; outer surface with moderately dense to dense stellate hairs with *c.* 12 arms, each to 0.3 mm long, with dense red-tipped glandular hairs to 1.5(–2.5) mm long towards the lower 1/3 and to 0.4 mm long for the remainder; inner surface glabrous at base with scattered to moderately dense white simple hairs or stellate hairs with 2–6 arms, each to 0.2 mm long, towards the apex, glandular hairs absent. *Staminal filaments* 0.3–0.4 mm long. *Anthers* 0.8–1.5 mm long, 0.5–0.8 mm wide. *Ovary* 0.9–1.5 mm long, 0.9–1.5 mm wide; outer surface with dense stellate hairs to 0.3 mm long, glandular hairs absent or scattered towards the apex. *Style* 2.7–3.9 mm long. *Fruit* ellipsoid, 2.9–4.5 mm long, 2.9–4.5 mm wide with dense stellate hairs and scattered inconspicuous glandular hairs 0.3 mm long towards the apex. *Seed* ellipsoid, dull blackish brown with few stellate hairs, *c.* 2 mm long, *c.* 1 mm wide; aril a cream cap with 2 arms as long as the seed and 3 shorter arms, *c.* 2.7 mm long, *c.* 1 mm wide. (Figure 3)

Diagnostic features. The following combination of features differentiates *L. decoratum* from related species in the *L. bracteatum* group: leaves thick and stiff, ovate to broadly ovate and densely hairy to tomentose below; inflorescence a loose dichasium with 6–12(–18) flowers; calyx lobes narrow (1.3–2.1 mm wide) with long glands up to 2.5 mm long on the outer surface.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 3 Dec. 2008, *A. Crawford* 1905 (PERTH); 25 Sep. 1988, *E.A. Griffin* 5278 (PERTH); 5 Dec. 1992, *E.A. Griffin* 8239 (PERTH); 16 Mar. 2006, *F. Hort* 2992 (K, PERTH); 8 Oct. 1991, *S. Patrick* SP 888 (PERTH); 6 Aug. 1992, *S. Patrick* SP 1161 (PERTH); 21 Nov. 2002, *S. Patrick & G. Paczkowska* PS 4550 (PERTH).

Phenology. Flowering begins in spring and extends through to summer from August to December. Fruits form through early summer from November and December.

Distribution and habitat. From the southern margin of the Geraldton Sandplains and eastern edge of the Jarrah Forest bioregions, north of Badgingarra and near Toodyay (Figure 2). This species is found in the gullies and slopes of breakaways in grey, brown or brown-yellow, loamy sand and lateritic gravel and boulders, growing in Mallee over heath, or low woodlands of *Eucalyptus accedens* or *Xylomelum* and *Banksia*.

Conservation status. This species is currently listed by Smith and Jones (2018) as Priority Two under Conservation Codes for Western Australian Flora, under the name *L.* sp. Badgingarra (E.A. Griffin 5278). While this species has a relatively restricted distribution, the three known populations occur within the conservation estate.

Etymology. The epithet is from the Latin *decoratum* (decorate), and refers to the attractiveness of this species with its prolific pink flowers and showy pink epicalyx bracts.

Affinities. *Lasiopetalum decoratum* is similar to *L. molle* in having ovate, thick, stiff leaves that are somewhat rugose with densely hairy to tomentose stellate hairs on the abaxial surface; however, it differs in having recurved rather than strongly revolute leaf margins, a loose inflorescence,

Figure 3. *Lasiopetalum decoratum*. A – habit; B – shrub showing masses of pink flowers with large, petaloid epicalyx bracts and discolorous leaves; C – loose dichasial inflorescences of pink flowers with a deep red base and dense glands on each peduncle, pedicel and outer calyx; D – broadly ovate, rugose, thick and stiff leaves with a slightly cordate base and pink flowers with narrow calyx lobes. Voucher: *F. Hort* 2926. Images: F. & J. Hort.

flowers with narrower calyx lobes (1.3–2.1 mm wide vs 2–2.6 mm) and a mauvish pink calyx with a dark red base only, as opposed to a pink calyx with the base and the centre of each lobe being dark red to red.

Lasiopetalum membranaceum (Steud.) Benth., *Fl. Austral.* 1: 266 (1863). *Corethrostylis membranacea* Steud. *Pl. Preiss. [J.G.C. Lehmann]* 1(2): 236 (1845). *Type citation*: 'In arenosis colliculosis sylvae ad portum Lechenault, ditionis Wellington, 13. Dec. 1839. Herb. Preiss. No. 1656.' *Type specimen*: Wellington [Western Australia], 13 December 1839, *Preiss* 1656 (*lecto*, here designated: P 02142993 image!; *isolecto*: BR 0000013331498 image!; F l010364 image!; G 00358450 [two specimens] image!; G 00358451 image!; HBG 512352 image!; K 000686558! [right hand specimen]; LD 1418052!; MEL 52357!; MEL 52358!; MEL 52359!; MO 357429 image!; P 02142994 image!; S 12-17746 image!; TCD 0010956 image!; W 310082!; W!).

Erect, spreading *subshrub* or *shrub* (0.2–)0.3–0.5(–1) m high, 0.5–1 m wide. *Young stems* with a dense indumentum of scattered to moderately dense stalked (to 0.6 mm long) stellate hairs with *c.* 12 arms, each to 1.1 mm long, above scattered to moderately dense stellate hairs with *c.* 6 arms, each to 0.4 mm long, and scattered red-tipped glandular hairs to 0.6 mm long. *Petioles* (1.8–)10–20.8 mm long, indumentum as for young stems. *Leaves* pliable, ovate, scarcely discolorous, (8–)19.5–39 mm long, (8–)11–27 mm wide, base slightly to moderately cordate, apex acute or rounded-acute; margins entire to sinuate, slightly to moderately recurved; abaxial surface with scattered to moderately dense stalked (*c.* 0.3 mm long) or sessile stellate hairs with *c.* 10 arms, each to 0.8 mm long, and occasional to scattered glandular hairs to 0.5 mm long; adaxial surface smooth or scarcely rugose with scattered stalked (*c.* 0.3 mm long) stellate hairs with *c.* 10 arms, each to 0.7 mm long, glandular hairs absent, glabrescent. *Inflorescence* a loose dichasium, 38–81 mm long, with 7–14 flowers. *Peduncles* 19–30.6 mm long, with scattered stalked (to 0.4 mm long) stellate hairs with *c.* 8 arms, each to 1.6 mm long, over moderately dense to dense stellate hairs with *c.* 8 arms, each to 0.3 mm long, and moderately dense red-tipped glandular hairs to 0.5 mm long. *Pedicels* 4.2–9.5(–14) mm long, indumentum as for peduncles but without the scattered large stellate hairs. *Bract* narrowly ovate, 2.1–4.3(–7) mm long, 0.6–2(–3) mm wide. *Epicalyx bract* attachment usually mid-pedicel *c.* 4 mm below the calyx, with a dark pink stalk *c.* 0.5 mm long, blade ovate, mauvish pink, 3.2–6.5 mm long, 2.1–4.1 mm wide; abaxial surface and margin with scattered stalked stellate hairs with 10–12 arms, each to 1.3 mm long, and occasional glandular hairs to 0.3 mm long; adaxial surface with moderately dense sessile stellate hairs with 4–6 arms, each to 0.2 mm long, and occasional glandular hairs to 0.3 mm long. *Calyx* mauvish pink, dark red at the base and centre of each lobe, sometimes grading to pale green, 5.3–6.3 mm long, with a tube 1.3–1.4 mm long, lobes narrowly ovate, 4.9–6.5 mm long, 2.3–3.5 mm wide; outer surface with dense to tomentose stellate hairs with 8–10 arms, each to 0.25 mm long and moderately dense to dense red-tipped glandular hairs *c.* 1.1 mm long towards the lower 1/3, *c.* 0.5 mm long for the remainder; inner surface glabrous towards the base, with moderately dense simple or stellate hairs with 1–6 arms, each to 0.2 mm long, towards the apex, glandular hairs absent. *Staminal filaments* 0.5–0.6 mm long. *Anthers* 1.4–1.9 mm long, 0.8–0.9 mm wide. *Ovary* 0.9–1 mm long, 0.9–1 mm wide; outer surface tomentose, with stellate hairs to 0.2 mm long, inconspicuous glandular hairs present or absent. *Style* 2.5–3 mm long. *Fruit* ellipsoid, 3.6–4.5 mm long, 3.3–4 mm wide, with residual dense stellate hairs and scattered glandular hairs to 0.15 mm long. *Seed* dull blackish brown with few stellate hairs, body *c.* 2.5 mm long, 1.7 mm wide; aril a cream cap with 3–5 arms reaching to mid-length of seed, *c.* 1.3 mm long, *c.* 1 mm wide. (Figure 4)

Diagnostic features. *Lasiopetalum membranaceum* may be distinguished from other species in the genus with petaloid epicalyx bracts by the following: pliable ovate leaves with a slightly to moderately cordate base, long petioles (1.8–)10–20.8 mm, and scattered to moderately dense large stellate hairs only on the abaxial surface. The mauvish pink calyx lobes have an acuminate apex and are broad (to 3.5 mm wide). The inner surface of the calyx is also distinctive as the deep red colour at the base extends upwards to more than halfway through the centre of each lobe, sometimes grading to green (Figure 4D).

Figure 4. *Lasiopetalum membranaceum*. A – habit; B – ovate, slightly to moderately cordate leaves with a scarcely rugose surface; C – flower showing the narrowly elliptic, petaloid epicalyx bracts towards the base of each pedicel and splayed calyx lobes with short glandular hairs; D – pink flower showing the deep red colour at the base extending upwards towards the centre of each lobe (sometimes grading to green). Unvouchered specimens from Kings Park. Images: K.A. Shepherd and M. Brotherson.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 24 Oct. 1998, *B. Bischoff* BNC 829 (PERTH); 4 Dec. 1971, *M.L. Cambridge s.n.* (PERTH 02704587); 7 Jan. 2009, *B. Fellows & J. Waud* BCF 82 (K, PERTH); 23 Nov. 1998, *S.A. Fisher* 315 (PERTH); 19 Mar. 2001, *A. Horan s.n.* (PERTH 05767563); 19 Oct. 1995, *B.J. Keighery* 2440 (PERTH); 4 Nov. 1987, *G.J. Keighery & J.J. Alford* 1604 (PERTH); 5 Dec. 1992, *G.J. Keighery* 12740 (PERTH); 10 Nov. 1969, *V. Mann & A.S. George* 42 (PERTH); 14 Feb. 2001, *G.S. McCutcheon* GSM 3020 (PERTH); 1 Nov. 2005, *Wildflower Society of W.A. Paganoni* PAG OP/36 (PERTH); 20 Oct. 1972, *S. Paust* 1366 A (CANB, PERTH); 6 Nov. 2003, *C. Smith s.n.* (PERTH 06586384); 23 Oct. 1994, *C. Tauss s.n.* (PERTH 03980820); Nov. 1920, *E.H. Wilson & D.A. Herbert s.n.* (PERTH 01046101); 8 Dec. 1993, *C.F. Wilkins & K.A. Shepherd* CW 622 (PERTH); 18 Jan. 1994, *C.F. Wilkins & K.A. Shepherd* CW 630 (PERTH); 24 Apr. 1994, *C.F. & J. Wilkins* CW 673 (PERTH); 28 Sep. 2003, *C.F., J.A., S.A. Wilkins & S. Blake* CW 1778 (PERTH).

Phenology. *Lasiopetalum membranaceum* flowers from mid-spring to summer. Fruits appear in summer from December.

Distribution and habitat. This species is usually found in the Jarrah Forest, Swan Coastal Plain and Warren bioregions of the South West Botanical Province in white or grey sand over limestone associated with *Eucalyptus gomphocephala*, *E. marginata*, *Banksia* or *Allocasuarina* woodlands. It is naturally occurring in Kings Park and extends southwards along the coast to near Black Point east of Augusta (Figure 2). An outlying collection currently determined as *L. membranaceum* was made near Tarin Rock in the Mallee bioregion. This collection was recorded as growing on grey sand over laterite associated with *Allocasuarina*, *Grevillea* and *Chamelaucium* shrubland. Further collections are required from this location to confirm the taxonomic status of this population.

Conservation status. This species is currently listed by Smith and Jones (2018) as Priority Three under Conservation Codes for Western Australian Flora. While *L. membranaceum* has historically been found at a number of sites in the Swan Coastal Plain south of the city of Perth, populations are in close proximity to urban regions and may be subject to increasing pressure from development, fire frequency and encroachment of weeds. More field work is required to determine the health of populations across the known distribution of this species, particularly on the Swan Coastal Plain.

Affinities. See notes under *L. bracteatum*.

Typification. The P 02142993 *Preiss* 1656 specimen at the Museum National d'Histoire Naturelle is designated herein as the lectotype. This sheet comprised part of Steudel's own herbarium indicated by the left hand label bearing the distinctive red 'Herbarium Steudel' annotation at the top, with notes in handwriting that is comparable to the examples given in Cloike (1964, Plate 11: 2 & 3).

The specimen on the left hand side of the K 000686558 isolectotype is a *Drummond* 155 collection (K 000686559) and is not considered to be type material.

Lasiopetalum molle Benth., *Fl. Austral.* 1: 266 (1863). *Type citation*: '*Drummond, n.* 26 and 108'. *Type specimens*: Swan R[iver, Western Australia, 1842], *J. Drummond* 2: 26 (*lecto*, here designated: K 000686068!; *isolecto*: G 00358452 image!; G 00358453 image!; K 000686065! [left hand specimen 'a']; LD 1615045!; P 02142991 image!); Swan R[iver, Western Australia], *J. Drummond* 3: 108 (*syn*: E 00279385 image!; G 00358454 image!; G 00358455 image!; G 00358456 image!; K 000686064! [right hand specimen]; K 000686066!; P 02142992 image!; TCD 0010946 [left hand specimen] image!).

Erect or spreading *subshrub* or *shrub* (0.2–)0.3–1.5(–2) m high, 0.5–1.7 m wide. *Young stems* with a dense to tomentose indumentum of moderately dense sessile or stalked (*c.* 0.15 mm long) stellate hairs with 8–10 arms, each to 0.3 mm long, over moderately dense stellate hairs with *c.* 6 arms, each to 0.25 mm long, and occasional red-tipped glandular hairs to 0.4 mm long. *Petioles* (2.8–)3.8–8.2(–15) mm long, indumentum as for young stems. *Leaves* thick and stiff, narrowly ovate to ovate, strongly discolorous, (5–)14–24.3(–39) mm long, (3–)6.7–12(–25) mm wide, base slightly cordate, apex acute or rounded-acute; margins entire to sinuate, strongly recurved to inrolled; abaxial surface tomentose, with scattered stalked (*c.* 0.2 mm long) stellate hairs on veins with *c.* 14 arms, each to 0.3 mm long, over stellate hairs with *c.* 12 arms, each to 0.3 mm long, and glandular hairs to 0.25 mm long present or absent on rib; adaxial surface rugose, new growth with dense stalked (to 0.25 mm long) stellate hairs with *c.* 12 arms, each to 0.3 mm long, with scattered glandular hairs to 0.2 mm long, glabrescent with residual glandular hairs and hair stalks. *Inflorescence* a compact dichasium, 19–50 mm long, with (7–)9–11(–18) flowers. *Peduncles* 8–14.3 mm long, with dense sessile or occasionally stalked (*c.* 0.15 mm long) stellate hairs with 12–16 arms, each to 0.35 mm long, and occasional to moderately dense red-tipped glandular hairs to 0.6 mm long. *Pedicels* 1.8–5.3 mm long, indumentum as for

peduncles. *Bract* elliptic, narrowly ovate or ovate, 1.2–2.7(–4.3) mm long, 0.3–0.7(–1.6) mm wide. *Epicalyx bract* attachment towards the upper pedicel, 0.5–1.3 mm below the calyx, with a dark pink stalk 0.5–1 mm long, blade ovate, mauvish pink, 4.5–6.6 mm long, 3.1–5.2 mm wide; abaxial surface with dense stellate hairs with *c.* 12 arms, each to 0.4 mm long, with scattered glandular hairs to 0.4 mm long; adaxial surface with moderately dense stellate hairs with *c.* 4–6 arms, each to 0.2 mm long, and scattered glandular hairs to 0.25 mm long. *Calyx* mauvish pink to pale pink, base and central lobe dark red, rarely with green and dark red markings, 5.8–7.5 mm long with a tube 0.5–1.2 mm long; lobes narrowly ovate, 4.8–6.5 mm long, 2–2.6 mm wide; outer surface with dense stellate hairs with *c.* 12 arms, each to 0.6 mm long, and moderately dense red-tipped glandular hairs to 1.8 mm long towards the lower 1/3, *c.* 0.4 mm long for the remainder; inner surface with glabrous base and scattered to moderately dense simple or stellate hairs with 2–6 arms, each to 0.2 mm long, towards the apex, glandular hairs absent. *Staminal filaments* 0.5–0.8 mm long. *Anthers* 1.7–2 mm long, 0.6–1mm wide. *Ovary* 0.5–1 mm long, 0.5–1 mm wide; outer surface with dense stellate hairs to 0.3 mm long, glandular hairs absent. *Style* 3.3–3.9 mm long. *Fruit* ellipsoid, *c.* 4 mm long, *c.* 4 mm wide, with residual stellate hairs, glandular hairs absent. *Seed* dull blackish brown with occasional stellate hairs, aril a cap with 2 long arms almost to full length of seed and 4 shorter arms. (Figure 5)

Diagnostic features. *Lasiopetalum molle* is distinguished from allied species in the *L. bracteatum* group by the following combination of characters: leaves thick and stiff, narrowly ovate to ovate with strongly recurved to inrolled margins, rugose above (Figure 5C) and with a tomentose indumentum of stellate hairs below; inflorescences compact, comprising mauvish pink to pale pink flowers with broad calyx lobes 2–2.6 mm wide with a dark red base that extends up the centre of each lobe (Figure 5D).

Selected specimens examined. WESTERN AUSTRALIA: *c.* 22 km W of Newdegate on road to Lake Grace, 1 Sep. 1990, *D.E. Albrecht & B.A. Fuhrer* DEA 4120 (CANB, MEL, PERTH); Tarin Rock, 7 Sep. 1966, *A.M. Ashby* 1952 (PERTH); 33 miles W of Lake Grace, 28 Aug. 1968, *E.M. Bennett* 2276 (BRI, CANB, K, PERTH); Dilling Railway Rd, 6 km from Corrigin, 6 May 1997, *R. Davis* 3122 (PERTH); junction of Higginson Rd and Deep Well Rd *c.* 15 km N of Kellerberrin, 12 Oct. 2000, *R. Davis* WW 17-53 (PERTH); *c.* 7–9 km E of Dumbleyung on Wagin to Lake Grace Rd, 17 Sep. 1984, *D.B. Foreman* 748 (BRI, K, MEL, PERTH); E Bendering Reserve Rd, 26 Aug. 2001, *J.P. Francis* 61 (PERTH); 0.05 km E of Burngup South Rd on southern boundary of South Buniche NR, 2 Feb. 1998, *M.S. Graham* MSG 938 (PERTH); southern end of bush remnant on Konnongorring – Dowerin Rd *c.* 7 km E of Konnongorring, 13 Sep. 2005, *M. Hislop* 3512 (AD, PERTH); on the northern boundary of Water Reserve 16418, 1.3 km W of Craig Rd junction, *c.* 4 km NW of Wongan Hills, 18 Sep. 1998, *G.J. Keighery & N. Gibson* 5956 (PERTH); 32 km S of Pithara to Wongan Hills, 23 Aug. 1973, *B.R. Maslin* 3377 (CANB, PERTH); 17.5 km E Lake Grace to Newdegate, 28 Aug. 1973, *B.R. Maslin* 3426 (AD, PERTH); Wyalgima Hill *c.* 11 km N of Beverley, 15 July 1999, *L.W. Sage, J.P. & E.B. Pigott* LWS 1551 (PERTH); Burngup Water Reserve, Solomko Rd, 50 m N Mallet Ridge, 18 Sep. 1996, *M. & J. Stewart* 14 (CANB, NSW, PERTH); Gardner Reserve, S of Tammin, 25 Nov. 1994, *K.A. Shepherd & C.F. Wilkins* KS 144 (PERTH); 25.7 km E Lake Grace toward Newdegate, 9 Sep. 1994, *K.A. Shepherd, J.A. Chappill & J.A. Wege* KS 76 (PERTH); E of Dumbleyung on Lake Grace Rd, 23 Nov. 1993, *C.F. Wilkins* CW 369 (PERTH); Wongan to Pithara Rd, 11 Sep. 2003, *C.F. Wilkins & J.A. Wege* CW 1707 (PERTH); 600 m from Quairading to Cunderdin Rd along a breakaway, 9 Oct. 2004, *C.F. & J.A. Wilkins* CW 1968 (MEL, PERTH).

Phenology. Winter and spring flowering from June to October. Fruiting from early to mid-summer.

Distribution and habitat. From Wongan Hills to Newdegate in the Avon Wheatbelt and Mallee bioregions of the South West Botanical Province in Western Australia (Figure 2). This species grows in

Figure 5. *Lasiopetalum molle*. A – habitat; B – habit; C – dichasial inflorescence and narrowly ovate, thick and stiff leaves with a slightly to moderately cordate base and slightly rugose surface with scattered residual hair stalks; D – pale pink flowers covered in stellate and glandular hairs with broadly ovate, pale pink, petaloid epicalyx bracts (black arrow) and pale pink calyx lobes with a deep red base and centre. Voucher: *K.A. Shepherd & C.F. Wilkins* KS 1612. Images: K.A. Shepherd.

open mallee woodland with scrub or heath, often on breakaways of lateritic ridges or in creek beds, in yellow, yellow to red-brown, grey or white sandy clay or sand, mainly with lateritic gravel over granite.

Conservation status. This species is relatively widespread and not considered to be under threat at this time.

Affinities. See notes under *L. decoratum*.

Typification. Bentham had access to material from various herbaria while compiling *Flora Australiensis*. His own herbarium included, in part, specimens from Hooker's Herbarium now housed at Kew. Both Drummond's '26' gathering from his second series and the '108' gathering from his third series match the protologue, with many of the duplicates being of reasonable quality. The K 000686068 specimen is a good match for the protologue and is the only sheet of the *Drummond* 2: 26 collections seen to date that bears the Herbarium Hookerianum stamp and as such is selected as the lectotype. On the K 000686064 sheet (*Drummond* 108, Herbarium Hookerianum) only the right hand fragment is *L. molle*; the two left hand fragments are *L. rotundifolium*.

Lasiopetalum rotundifolium Paust, *Nuytsia* 1(4): 356, Figures 6, 12 (1974). *Type*: 5–6 miles south of New Norcia, Western Australia, 1 October 1947, *C.A. Gardner* 8690 (*holo*: PERTH 1096338!; *iso*: CANB *n.v.*, K 000749705!).

Erect to spreading *subshrub* or *shrub* 0.5–1.5 m high, 0.6–0.8 m wide. *Young stems* with a tomentose indumentum of scattered to moderately dense stalked (to 0.8 mm long) or sessile stellate hairs with *c.* 12 arms, each to 1.2 mm long, over dense sessile stellate hairs with *c.* 12 arms, each to 0.4 mm long, with or without scattered glandular hairs to 0.7 mm long. *Petioles* 2.4–4.5(–9) mm long, indumentum as for young stems. *Leaves* thick and stiff, orbicular, discolorous, 6–24 mm long, 6–23.8 mm wide, base deeply cordate, apex rounded, rarely rounded-acute; margins irregularly sinuate, strongly recurved; abaxial surface tomentose, with scattered stalked (to 0.6 mm long) stellate hairs with *c.* 12 arms, each to 1.1 mm long, above dense sessile stellate hairs with *c.* 12 arms, each to 0.4 mm long, and scattered glandular hairs to 0.4 mm long on rib; adaxial surface rugose, new growth with dense stalked (*c.* 0.3 mm long) stellate hairs with *c.* 16 arms, each to 0.6 mm long, over stellate hairs and scattered glandular hairs to 0.4 mm long, glabrescent with residual glandular hairs and hair stalks. *Inflorescence* a compact dichasium, 26–42 mm long, with 9–14(–16) flowers. *Peduncles* 8.5–15 mm long, with dense sessile or occasionally stalked (to 0.7 mm long) stellate hairs with *c.* 12 arms, each to 0.5 mm long, with scattered red-tipped glandular hairs to 0.7 mm long. *Pedicels* 3.1–6 mm long, indumentum as for peduncles except for moderately dense rather than scattered glandular hairs. *Bract* ovate to narrowly elliptic, 3.5–5 mm long, 0.7–2.8 mm wide. *Epicalyx bract* attachment mid to upper pedicel *c.* 2 mm below the calyx, with a dark pink stalk to 0.3 mm long, blade ovate, mauvish pink, 3.6–11 mm long, 3–8.8 mm wide; abaxial surface with dense stellate hairs with *c.* 12 arms, each to 0.7 mm long, with or without scattered glandular hairs; adaxial surface with dense stellate hairs with *c.* 6 arms, each to 0.3 mm long, with or without scattered glandular hairs to 0.25 mm long. *Calyx* mauvish pink, green at the base and centre of lobe with a dark red patch in the middle, 6.3–8.5 mm long with a tube 0.8–1.2 mm long; lobes narrowly ovate, 5.1–6.5 mm long, 1.3–2.7 mm wide; outer surface with dense sessile stellate hairs with *c.* 12 arms, each to 0.3 mm long and moderately dense red-tipped glandular hairs *c.* 2.3 mm long towards the lower 1/3, *c.* 0.4 mm long for the remainder; inner surface glabrous at base, with moderately dense simple or stellate hairs with 1–6 arms, each to 0.2 mm long, at the centre and apex, glandular hairs absent. *Staminal filaments* 0.4–0.6 mm long. *Anthers* 1.7–1.8 mm long, 0.6–1.2 mm wide. *Ovary* 1–1.1 mm long, 1–1.1 mm wide; outer surface with dense stellate hairs to 0.25 mm long, glandular hairs absent. *Style* 2.9–4.1 mm long. *Fruit* ellipsoid, 3.5–4 mm long, 3–3.5 mm wide, with residual dense stellate hairs, glandular hairs absent. *Seed* dull blackish brown with few to moderately dense white stellate hairs, 1.8–2.3 mm long, 1–1.1 mm wide, aril a cream cap with 1 arm almost length of seed and 2 or 3 shorter arms, *c.* 2 mm long, *c.* 1 mm wide. (Figure 6)

Diagnostic features. *Lasiopetalum rotundifolium* is readily identified within the genus by its orbicular leaves, which are discolorous, thick and stiff, with a deeply cordate base and tomentose indumentum on the abaxial surface. The inflorescence is a compact dichasium 26–42 mm long of mauve-pink flowers that are green at the base and along the central lobe with a dark red patch in the middle (Figure 6D).

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 12 Oct. 1999, *D. Box* 272 (PERTH); 19 Nov. 1998, *J.A. Cochrane* JAC 3012 (PERTH); 8 May 1997, *R. Davis* 3185 (PERTH); 13 Dec. 2007, *T. Erickson & T. Clifton* TEE 293 (K, PERTH); 29 Sep. 2004, *F. & B. Hort & J. Brown* 2318 (PERTH); 9 Sep. 1998, *K. Kershaw s.n.* (CANB, DNA, PERTH 05426472); 2 Sep. 1999, *K. Kershaw* 2012 (AD, MEL, NSW, PERTH); 7 Sep. 1999, *K. Kershaw* 2015 (K, NSW, PERTH); 30 Sep. 1999, *K. Kershaw* 2033 (BRI, DNA, HO); 25 Oct. 2002, *K. Kershaw & L. Sage* KK 2341 (CANB, PERTH); 14 Sep. 1995, *J. Page* JP 8 (PERTH); 21 Sep. 2016, *K.A. Shepherd*

Figure 6. *Lasiopetalum rotundifolium*. A – habitat; B – habit; C – orbicular, stiff and discolorous leaves with a deeply cordate base and rounded apex; D – dichasial inflorescence of flowers covered in stellate and glandular hairs, with broadly ovate, pale pink, petaloid epicalyx bracts (white arrow), and pale pink calyx lobes that are green at the base and centre of each lobe with a dark red patch in the middle. Vouchers: *K.A. Shepherd, S. Willis, F. Walmsley & C. Shepherd* KS 1629 (A, C) and *K.A. Shepherd & C.F. Wilkins* KS 1619 (B, D). Images: K.A. Shepherd.

& C.F. Wilkins KS 1619 (PERTH); 8 Oct. 2016, *K.A. Shepherd, S.R. Willis, F. Walmsley & C. Shepherd* KS 1629 (CANB, MEL, PERTH); 9 Oct. 2004, *C.F. Wilkins & J.A. Wilkins* CW 1962 (MEL, PERTH).

Phenology. Flowering from spring to early summer and fruiting from early to mid-summer.

Distribution and habitat. *Lasiopetalum rotundifolium* is currently known from only a few populations around Pingelly and Narrogin near the boundary between the Avon Wheatbelt and Jarrah Forest bioregions of the South West Botanical Province (Figure 2). The type collection was made in the 1940s from near New Norcia but there are no extant populations currently recorded from this area.

This species is found on red-brown, lateritic, sandy loam over laterite, in open *Eucalyptus marginata* or *E. accedens* woodlands, over shrubs or heath.

Conservation status. This species was presumed extinct until the authors rediscovered it in 1994. *Lasiopetalum rotundifolium* is currently listed as Threatened in Western Australia under the category of Endangered and therefore considered to be facing a very high risk of extinction (Smith & Jones 2018).

Affinities. *Lasiopetalum rotundifolium* is similar to *L. molle* in having a compact inflorescence and stiff, rugose, leaves. It is readily distinguished from it by the orbicular and deeply cordate leaves (*cf.* ovate or narrowly ovate and slightly cordate), somewhat broader epicalyx bracts 3–8.8 mm wide (*cf.* 3.1–5.2 mm) and the pale pink calyx lobes having a green base with a dark red patch (*cf.* dark red base that extends up the centre of each lobe).

While *L. rupicola* has leaves that are orbicular and deeply cordate like *L. rotundifolium*, they are pliable and scarcely discolorous rather than stiff and discolorous.

Lasiopetalum rupicola K.A.Sheph. & C.F.Wilkins, *sp. nov.*

Type: private property between Cataby and Dandaragan, Western Australia [precise locality withheld for conservation reasons], 22 August 2016, *K.A. Shepherd & C.F. Wilkins* KS 1595 (*holo*: PERTH 08877866; *iso*: AD, BRI, CANB, MEL, NSW).

Lasiopetalum sp. Hill River (T.N. Stoate 5), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 30 January 2018].

Lasiopetalum miseryense E.M.Benn. & K.Shepherd ms, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 30 January 2018]; G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 543 (2000), *nom. inval.*

Erect, spreading *subshrub* or *shrub* (0.2–)0.3–1.5(–2) m high, 0.5–1.7 m wide. *Young stems* with a dense indumentum of sessile or occasionally stalked (to 0.7 mm long) stellate hairs with *c.* 12 arms, each to 1.5 mm long, over moderately dense stellate hairs with *c.* 6 arms, each to 0.4 mm long, with scattered to moderately dense red-tipped glandular hairs to 1.3 mm long. *Petioles* 4.1–12.2 mm long, indumentum as for young stems. *Leaves* pliable, orbicular, rarely broadly ovate, scarcely discolorous (5.5–)8–27.3 mm long, (6.5–)9.1–26.4 mm wide, base deeply cordate, apex rounded; margins entire to sinuate, strongly recurved; abaxial surface with scattered to moderately dense sessile or stalked stellate hairs with *c.* 8 arms, each to 0.8 mm long, with or without scattered glandular hairs on the rib to 0.3 mm long; adaxial surface rugose, new growth with moderately dense stalked (*c.* 0.5 mm long) stellate hairs with *c.* 10 arms, each to 0.7 mm long, with scattered glandular hairs to 0.3 mm long towards margins, glabrescent with glandular hairs and hair stalks remaining. *Inflorescence* a loose dichasium, 21–55 mm long, with 6–19 flowers. *Peduncles* 5.5–23.6 mm long, with occasional stalked (*c.* 0.3 mm long) stellate hairs with *c.* 12 arms, each to 0.5 mm long over moderately dense sessile stellate hairs with 6–10 arms, each to 0.3 mm long, with occasional or moderately dense red-tipped glandular hairs to 1.4 mm long. *Pedicels* 3.5–7.7 mm long, indumentum as for peduncles but without large stellate hairs. *Bract* ovate, 2–8 mm long, 1.1–4.9 mm wide. *Epicalyx bract* attachment mid- to lower pedicel, *c.* 2–6 mm below the calyx, with a dark pink stalk *c.* 0.5 mm long, blade ovate, mauvish pink, 4–8 mm long, 2.4–6 mm wide; abaxial surface with dense stalked and sessile stellate hairs with *c.* 8 arms, each to 0.6 mm long, and scattered glandular hairs to 0.5 mm long; adaxial surface

with moderately dense stellate hairs with *c.* 4–6 arms, each to 0.2 mm long, and scattered glandular hairs to 0.6 mm long. *Calyx* mauvish pink, base dark red without green markings, 5.5–6.5 mm long with a tube 0.5–0.7 mm long; lobes very narrowly ovate, 4.8–6 mm long, 1.2–1.3 mm wide; outer surface with dense stellate hairs with *c.* 6 arms, each to 0.3 mm long and moderately dense red-tipped glandular hairs 2.2 mm long towards the lower 1/3, to 0.5 mm long for the remainder; inner surface glabrous at base, with moderately dense simple or stellate hairs with 1–6 arms, each to 0.2 mm long, at centre and apex, glandular hairs absent. *Staminal filaments* 0.5–0.8 mm long. *Anthers* 1.4–1.5 mm long, 0.7–0.8 mm wide. *Ovary* 0.9–1 mm long, 0.9–1 mm wide; outer surface with dense stellate hairs to 0.2 mm long, inconspicuous glandular hairs present or absent. *Style* 2.5–3.3 mm long. *Fruit* ellipsoid, 3.6–4 mm long, 3–3.7 mm wide, with residual small stellate hairs, with or without scattered glandular hairs to 0.15 mm long. *Seed* dull blackish brown with few stellate hairs, aril a cream cap with 3–5 arms to halfway down seed. (Figure 7)

Diagnostic features. *Lasiopetalum rupicola* is a range-restricted species distinguished from other species by its orbicular leaves that are thin and pliable, with a deeply cordate base and scattered to moderately dense stellate hairs on both surfaces. The calyx lobes are also narrow, being 1.2–1.3 mm wide at the widest point.

Figure 7. *Lasiopetalum rupicola*. A – habitat; B – habit, C – orbicular to broadly ovate, scarcely discolorous leaves with a rounded apex and deeply cordate base; D – young dichasial inflorescence of pink flowers covered in stellate hairs and long glandular hairs, with ovate, dark pink bracts (black arrow) and broadly ovate, pale pink, petaloid epicalyx bracts (white arrow); E – flowers with narrow, pale pink calyx lobes, each with a deep red base. Voucher: *K.A. Shepherd & C.F. Wilkins* KS 1595. Images: K.A. Shepherd (A–D) and C.F. Wilkins (E).

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 11 Sep. 1988, *E.A. Griffin* 5051B (PERTH); 20 Sep. 1988, *S.D. Hopper* 6740 (PERTH); 25 Sep. 1991, *S.J. Patrick* SP 815 (PERTH); Oct. 1952, *T.N. Stoate* 5 (PERTH).

Phenology. Flowers and immature fruits observed on specimens collected in spring from September to October.

Distribution and habitat. Found in the Geraldton Sandplains bioregion on a steep hillside and summit of a mesa in brown loam with lateritic gravel and boulders associated with low heath of *Allocasuarina humilis*, *Daviesia*, *Grevillea* and *Hakea* on private property between Cataby and Dandaragan.

Conservation status. This species is currently listed by Smith and Jones (2018) as Priority One under Conservation Codes for Western Australian Flora, under the name *Lasiopetalum* sp. Hill River (T.N. Stoate 5). This species is currently only known from a single population in remnant native vegetation on private property, which is surrounded by cleared farmland. A Threatened species, *Eucalyptus dolorosa* Brooker & Hopper, also occurs in the immediate vicinity. While there have been no surveys in the area targeting *L. rupicola* it is probable that some effort has been undertaken to search for populations of *E. dolorosa*, and as *L. rupicola* is a relatively conspicuous plant (when in flower) one could surmise that it would be collected if observed. Moreover, as this species appears to grow in a very specific habitat it seems the potential for further viable populations to be discovered is relatively low. It is probable that this species will be recognised as Threatened in the future.

Etymology. From the Latin *rupes* (rock) *-cola* (inhabitant) in reference to where this species grows.

Affinities. *Lasiopetalum rupicola* is similar to *L. membranaceum* in having pliable leaves with scattered to moderately dense hairs on both leaf surfaces; however, it can be distinguished from this species as its leaves are orbicular and deeply cordate, rather than ovate with a slightly cordate base. The calyx lobes are also narrower than in *L. membranaceum* (1.2–1.3 mm wide vs 2.3–3.5 mm), there are long glandular hairs at the base of the outer surface of the calyx (to 2.2 mm vs *c.* 1.1 mm) and the base of the lobes are dark red rather than dark red at the base and centre of each lobe (sometimes grading to pale green) (Figure 7).

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References

Bentham, G. (1863). *Lasiopetalum*. *Flora Australiensis*. Vol. 1. p. 259–266. (Reeve and Co.: London.)

Cloike, H.M. (1964). *An account of the herbaria of the Department of Botany in the University of Oxford*. (Oxford University Press: London.)

Department of the Environment (2013). *Australia's bioregions (IBRA)*, IBRA7, Commonwealth of Australia. https://www.environment.gov.au/land/nrs/science/ibra#ibra [accessed 11 July 2017].

George, A.S. (2009). *Australian botanist's companion*. (Four Gables Press: Kardinya, Western Australia.)

Hercock, M. (2014). *The Western Australian explorations of John Septimus Roe 1829–1849*. (Hesperian Press: Carlisle, Western Australia.)

Shepherd, K.A. & Wilkins, C.F. (2015). A revision of species from the tribe *Lasiopetaleae* (Byttnerioideae: Malvaceae) with rostrate anthers. *Nuytsia* 25: 171–189.

Shepherd, K.A. & Wilkins, C.F. (2017). A revision of the *Lasiopetalum floribundum* group (Malvaceae), including recognition of four new species. *Nuytsia* 28: 273–298.

Shepherd, K.A. & Wilkins, C.F. (2018). Typification of *Lasiopetalum* and an interim key to the Western Australian species of the genus. *Nuytsia* 29: 181–192.

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 30 January 2018].

Steudel, E.T. (1845). Büttneriaceae R.Br. *In*: C. Lehmann (ed.) *Plantae Preissianae* 1. pp. 229–238. (Sumptibus Meissneri: Hamburgi.)

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Typification of *Lasiopetalum* and an interim key to the Western Australian species of the genus (Malvaceae: Byttnerioideae)

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Abstract

Shepherd, K.A. & Wilkins, C.F. Typification of *Lasiopetalum* and an interim key to the Western Australian species of the genus (Malvaceae: Byttnerioideae). *Nuytsia* 29: 181–192 (2018). *Lasiopetalum ferrugineum* Sm. is lectotypified and selected as the type for *Lasiopetalum* Sm. Notes on the variation within *L. rosmarinifolium* (Turcz.) Benth. are provided, with *L. rosmarinifolium* var. *latifolium* (Turcz.) Benth. and *L.* sp. Kukerin (C.A. Gardner 13646) treated as synonyms. A preliminary key to the species of Western Australian *Lasiopetalum* is also presented.

Introduction

Lasiopetalum Sm. is an endemic Australian genus with a centre of diversity in southern Western Australia (Western Australian Herbarium 1998–). Currently there are 41 species recognised within the state; however, published information about the group is limited. All previous keys to the members of the genus (Bentham 1863; Blackall & Grieve 1974, 1988; Grieve 1998; Marchant *et al.* 1987; Wheeler *et al.* 2002) are woefully out of date due to the recognition in recent years of ten new species and the reinstatement of *L. laxiflorum* (Benth.) F.Muell. and *L. glutinosum* (Lindl.) F.Muell. (Western Australian Herbarium 1998–; Shepherd *et al.* 2006; Bennett & Shepherd 2007; Meissner *et al.* 2014; Shepherd & Wilkins 2015, 2017, 2018). Providing up-to-date information on this genus is critical as 29 (58%) of the 50 taxa currently recognised in Western Australia are listed as rare or priority taxa of conservation concern (Smith & Jones 2018). Many of these are poorly known and lack detailed descriptive information, which poses significant problems particularly for conservation managers. Furthermore, there is little public information available for the seven unnamed informal taxa that remain on the Western Australian vascular plant census (Western Australian Herbarium 1998–). To partially remedy this, an interim key to the Western Australian species of *Lasiopetalum*, including these seven phrase-named taxa, is provided.

The opportunity is also taken to lectotypify *Lasiopetalum* and discuss the variation evident within *L. rosmarinifolium* (Turcz.) Benth., whereby two synonyms are established within it.

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Typification and new synonymies

Lasiopetalum Sm., *Trans. Linn. Soc. London* 4: 216 (1798). *Lectotype*, here designated: *Lasiopetalum ferrugineum* Sm. ex Andrews.

Notes. See below for explanation of lectotypification.

Lasiopetalum ferrugineum Sm. ex Andrews, *The Botanist's Repository for New, and Rare Plants* 3: t. 208 (1802). *Type specimen*: 'Mr. Lee's Garden, 1796; seeds from New South Wales.' (*lecto*, here designated: LINN-HS 403.1.1 image! [two left hand fragments '1']; *isolecto*?: 1909.LBG.8413 image!).

Lectotypifications. Smith (1798) established *Lasiopetalum* Sm. (Malvaceae) without providing a specific epithet for the species upon which this initial description was based. The first species to be formally recognised was *L. ferrugineum* Sm. ex Andrews, where Andrews (1802) acknowledged Smith for coining the name: 'For the Generic and Specific titles of this plant we are indebted to Dr. Smith, P. L. S. &c. and we do not think more appropriate ones could have been invented.' The plant illustrated in this publication (Pl. 208) was stated to have been 'raised at the Hammersmith Nursery, from seeds received from New South Wales in 1791'; however, no specimens attributed to being cultivated at that nursery have been located to date. While the illustration could serve as a type we argue the original material used by Smith to produce the generic description is available. Images of specimens from the Herbarium of James Edward Smith held at the Linnean Society of London can be viewed via http://linnean-online.org/smith_herbarium.html.

The earliest specimen of *Lasiopetalum* in the collection, which is designated here as the lectotype, comprises two fragments of *L. ferrugineum* on the left hand side of a single sheet (LINN-HS 403.1.1) with the description '1. Mr. Lee's Garden, 1796; seeds from New South Wales.' There is an annotation in Smith's hand on the bottom right of this sheet initialled 'J.E.S' that states 'Lasiopetalum ferrugineum Andr. t. 208 –' acknowledging the illustration in Andrews (1802). Smith (1812), in his entry in Rees' Cyclopaedia under *L. ferrugineum*, referenced the Andrews publication and also stated the species was 'Native of marshes in New South Wales, from whence the seeds were received in 1791, by Messers Lee and Kennedy.' An older collection of *L. ferrugineum* (LINN-HS 403.1.2) on the right hand side of the same sheet, designated with the following note '2. New South Wales. Mr. Lambert. 1803', is not type material. An annotation also in Smith's hand was found on a second sheet of *L. ferrugineum* (1909. LBG.8413) from his collection held at the World Museum Liverpool (LIV). This specimen has a note that states it was cultivated in the Cambridge garden from seeds collected in New South Wales. As no date is provided it is unclear if this material represents a possible isolectotype.

Lasiopetalum rosmarinifolium (Turcz.) Benth. *Fl. Austral.* 1: 264 (1863). *Sarotes rosmarinifolia* Turcz. *Bull. Soc. Imp. Naturalistes Moscou* 25(3): 149 (1852). *Type citation*: 'N. Holl. *Drum. V. n. 266*'. *Type specimens*: 'Swan River to Cape Riche [Western Australia], 1848, *J. Drummond* 5: 266 (*holo*: KW 001000136 image!; *iso*: G 00358459 image!; G 00358460 image!; K 000686573 [right hand specimen] image!; MEL 236526 image!; P 02142988 image!).

Lasiopetalum rosmarinifolium var. *latifolium* (Turcz.) Benth. *Fl. Austral.* 1: 265 (1863). *Sarotes latifolia* Turcz. *Bull. Soc. Imp. Naturalistes Moscou* 25(3): 150 (1852). *Type citation*: 'N. Holl. *Drum. V. n. 265*'. *Type specimens*: Swan River to Cape Riche [Western Australia], 1848, *J. Drummond* 5: 265 (*holo*: KW 001000137 image!; *iso*: G 00358461 image!; G 00358462 image!; K 000686575 [left hand specimen] and K 000686576 [right hand specimen] image!; MEL 236525 image!; P 02142989 image!).

Lasiopetalum sp. Kukerin (C.A. Gardner 13646), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 23 January 2018].

Notes. Considerable effort has been made over the years to clarify the variation in *L. rosmarinifolium* (Turcz.) Benth. and the complex has even been the subject of a Botany honours project at The University of Western Australia (Orifici 1996). This detailed taxonomic investigation confirmed the distinctiveness of the informal taxon *L.* sp. Mt Ragged (T.E.H. Aplin 4349) due to the presence of a mixture of stellate and glandular hairs on the outer calyx and ovary (see Figure 1F); however, the remaining variation across *L. rosmarinifolium s. lat.* remained intractable.

Lasiopetalum rosmarinifolium var. *latifolium* (Turcz.) Benth. is currently listed as a name of 'uncertain application' on the *Australian Plant Name Index* (CHAH 2006–). This taxon is not recognised in Western Australia (Western Australian Herbarium 1998–) but it has never been formally synonymised in the literature. While there is considerable morphological variation evident within *L. rosmarinifolium s. lat.* we also do not formally recognise var. *latifolium* here, although we do acknowledge that with further work it may be supported as distinct and warrant some form of taxonomic recognition. Originally described as *Sarotes latifolia* Turcz., *L. rosmarinifolium* var. *latifolium* generally represents specimens within the complex that have styles that are glabrous in the upper half (or with very few reflexed hairs) and with dense stellate hairs towards the base. The stellate hairs on the outer calyx tend to have shorter and thicker arms and some specimens (including the type) have leaves that are wider than typical, but all of these features are highly variable. Most specimens that correspond to var. *latifolium* are found near Ravensthorpe and extend eastwards through to a population near Cocklebiddy.

Some time ago the phrase name *L.* sp. Kukerin (C.A. Gardner 13646) was proposed to formalise the manuscript name *L. leucogriseum* ms (E.M. Bennett Jan. 1999 *in sched.*) to account for specimens within the complex usually found west of Ravensthorpe that have reflexed, fan-like hairs on the style and woolly stellate hairs on the outer calyx. It is clear after examining images of type material of *Sarotes rosmarinifolia* Turcz. housed at the National Herbarium of Ukraine (KW) (via *Global Plants*, https://plants.jstor.org/) and from the protologue, that this phrase name corresponds to typical *L. rosmarinifolium*. While two broad groups within *L. rosmarinifolium s. lat.* have been outlined here, there remains significant variation that cannot be readily categorised (including differences in the number of carpels in the ovary) and all features tend to overlap to some degree.

Notes on the key to species of *Lasioptalum* in Western Australia

The size and shape of juvenile leaves can vary significantly compared to those on adult plants. For example, the leaves of young *L. occidentale* K.A.Sheph. & C.F.Wilkins may be multi-lobed but as the plants mature they become consistently trilobed (Shepherd & Wilkins 2017). Juvenile leaves can be larger or smaller in size than typical and the indumentum may change during development (e.g. hair density can appear to decrease as the leaf lamina begins to expand). Due to this potential variation all characters in the key are based on observations of fully developed leaves from mature plants.

The presence, size, colour and type of hairs are often diagnostic in *Lasiopetalum* (and similar to hairs in the closely related genus *Thomasia* J.Gay, some species of which serve as vouchers for illustrations in Figure 1). As stated in Shepherd and Wilkins (2017), stellate hairs have multiangulate arms (Figure 1B) while flat scale-like hairs have fused arms that are rotate (align in one plane) (Figure 1H). Indumentum density is defined here as 'tomentose' when the hairs are very densely arranged and the epidermis obscured, 'dense' when hairs are overlapping but the epidermis is visible, 'moderately dense' when hairs are touching laterally, and 'scattered' when the hairs are well-separated. Some species have a

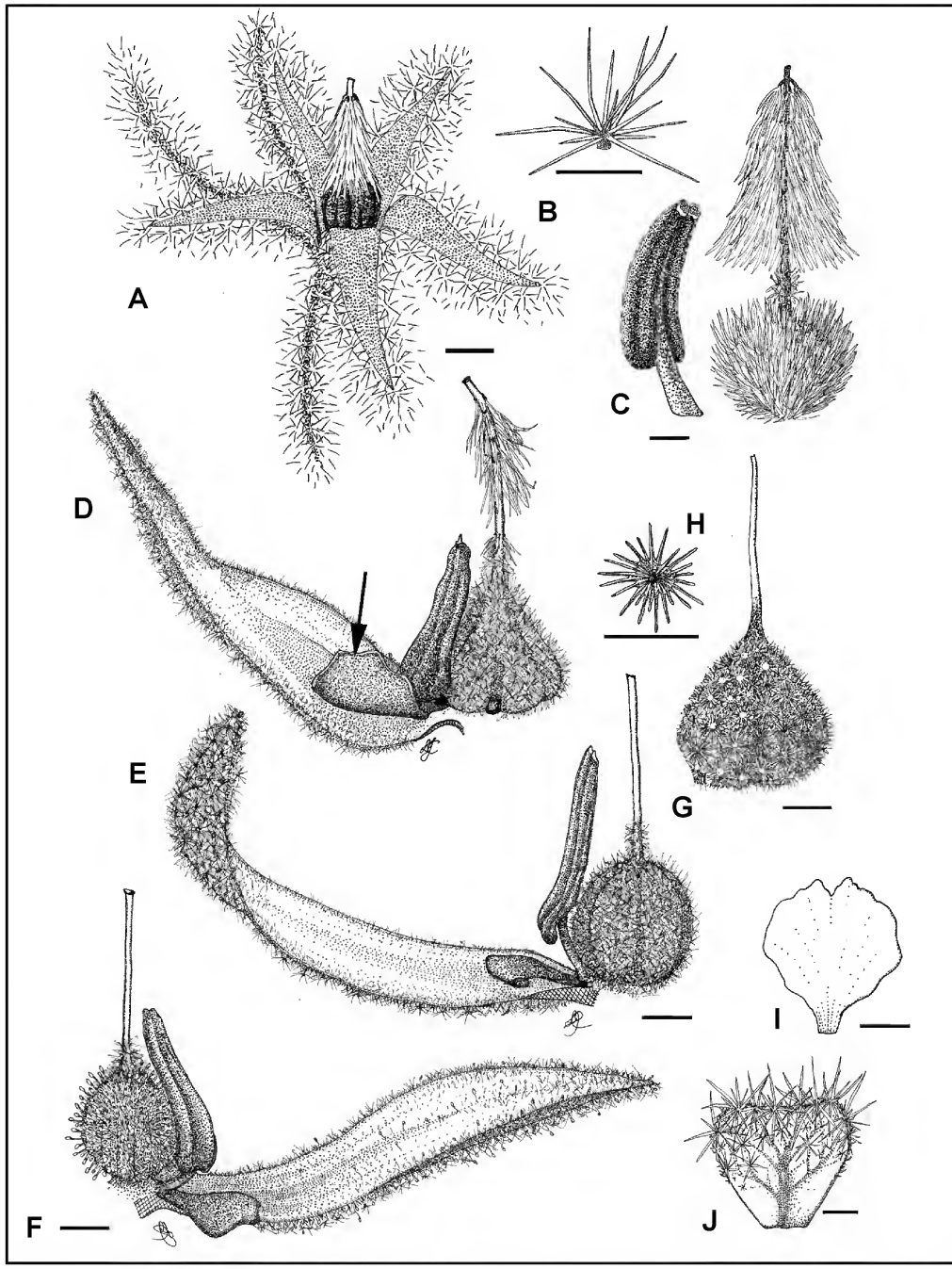

Figure 1. Floral features of *Lasiopetalum*. A – flower with a woolly indumentum on the outer calyx; B – mulitangulate stellate hair; C – anther with an obtuse apex, style with tomentose fan-like hairs, ovary covered in long, silky hairs; D – style with scattered fan-like hairs, glabrous scale-like petal (arrow); E – glabrous style, ovary with 'close' stellate hairs, each arm < 0.4 mm long; F – ovary with a mix of stellate and glandular hairs; G – ovary with scale-like hairs; H – flat scale-like hair; I – scale-like petal; J – scale-like petal with stellate hairs. Scale bars = 0.25 mm (H); 0.5 mm (C, G, I, J); 1 mm (B, D, E, F); 1.25 mm (A). Vouchers: *L.* sp. Watheroo (K. Shepherd & C. Wilkins KS 220) (*K.A. Shepherd & C.F. Wilkins* KS 220) (A, C, J); *Thomasia foliosa* J.Gay (*K.A. Shepherd* KS 399) (B, G, H); *L. rosmarinifolium* (*K.A. Shepherd s.n.*) (D, E); *L.* sp. Mt Ragged (T.E.H. Aplin 4349) (voucher unknown) (F), *T. rulingioides* Steud. (*K.A. Shepherd et al.* KS 201) (I).

woolly outer calyx where the tomentose hairs are long and intertwined (Figures 1A, 2B). The first step in the key separates species based on the presence or absence of hairs along the upper section of the style. Previously, species with stalked and reflexed stellate hairs that form a 'cylindrical or conical mass' along the length of the style (Figure 1A, C) were segregated into sect. *Corethrostylis* (Endl.) Benth. (Bentham 1863); however, this character is not consistent as species such as *L. rosmarinifolium* have some populations with glabrous styles and others that have styles with dense fan-like hairs along the upper section (Figure 1D–F). It should be noted that this species, like other taxa that are variable, may appear more than once in the key (designated by *). Ovary indumentum is also variable and hairs may be long and silky (Figure 1C), scale-like (Figure 1G), 'close' where the arms of the stellate hairs are short and < 0.4 mm long (Figure 1E), or papillate (covered in small wart-like bumps) as seen in *L. monticola* Paust. Finally the ovary may be covered in glandular hairs or a mixture of stellate and glandular hairs (Figure 1F) as seen in species such as *L.* sp. Mt Ragged (T.E.H. Aplin 4349).

Other distinctive floral characters include the presence of: reduced or scale-like petals (steps 2 and 11) that may be glabrous (Figure 1I; 2A) or covered in stellate hairs (Figure 1J); epicalyx bracts (step 4) that are large and petaloid (Figure 2B; also see Shepherd & Wilkins 2018) or linear to narrowly oblong

Figure 2. Informative floral characters in *Lasiopetalum*. A – reduced, scale-like petals (white arrow); B – style with a dense, conical mass of hairs (white arrow); epicalyx bract petaloid and broadly ovate (blue arrow); C – epicalyx bracts linear near the base of the calyx lobe (white arrow); D – epicalyx bracts fused to the base of each flower. Vouchers: *L. drummondii* Benth. (*K.A. Shepherd & C.F. Wilkins* KS 1605) (A); *L. rotundifolium* Paust (*K.A. Shepherd & C.F. Wilkins* KS 1619) (B); *L. glutinosum* subsp. *latifolium* (Benth.) K.A.Sheph. & C.F.Wilkins (*K.A. Shepherd & S.R. Willis* KS 1565) (C); *L. discolor* Hook. (*R. Cumming s.n.*). Images by K.A. Shepherd (A–C) and R. Cumming (D).

(Figure 2C); and anthers that are apically-beaked (step 30) and > 3 mm long (referred to as rostrate anthers; see Shepherd & Wilkins 2015) or with an obtuse or sub-acute apex (Figure 1C, 2B). Another feature that is somewhat difficult to describe is the fusion of the base of the epicalyx bracts (step 38). In some species the epicalyx bracts may be partially fused at the very base but this fusion is more obvious in *L. discolor* Hook. and *L. adenotrichum* R.A.Meissn. & Rathbone. Bentham (1863) stated that the bracts in *L. discolor* form an 'involucre around the soft woolly flower-heads' (Figure 2D). Finally, an inflorescence (step 9) may be loose when the flowers are well-spaced (Figures 2C, 3A) or compact such that the bases of the flowers are in close proximity or touching (Figures 2A, D, 3B).

Aspects of this key are adapted from those previously published in Shepherd and Wilkins (2015, 2017).

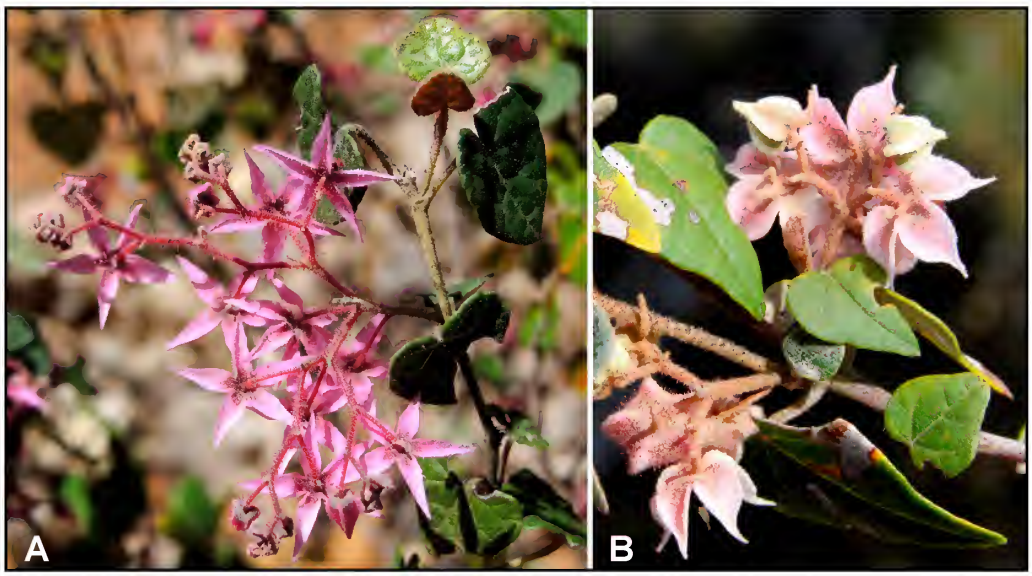

Figure 3. *Lasiopetalum* inflorescences. A – loose; B – compact. Vouchers: *L. cardiophyllum* Paust (*K.A. Shepherd & S.R. Willis* KS 1656) (A) and *L. cordifolium* Endl. (*K.A. Shepherd & C.F. Wilkins* KS 1647) (B). Images: K.A. Shepherd.

Interim key to *Lasiopetalum* in Western Australia

*taxa appear in more than one section of the key

1. Style upper 1/2 to 2/3 with stalked, reflexed, fan-shaped, stellate hairs (either a dense conical mass, scattered or occasional)

2. Apical leaves ± opposite, with alternate leaves below; scale-like petals present

3. Epicalyx bracts with stellate hairs and scattered red glandular hairs; calyx < 4 mm long (Kalbarri–Murchison Gorge).. ..... **L. oppositifolium***

3: Epicalyx bracts with stellate hairs only; calyx > 4 mm long (Shark Bay–Garden Island)..... **L. angustifolium**

2: All leaves alternate; scale-like petals present or absent

4. Epicalyx bracts petaloid, ovate to broadly ovate

5. Epicalyx bracts three (one large, two small), cream, close to the base of the calyx (Quairading–E of Jerramungup) ..... **L. microcardium**

5: Epicalyx bract solitary, bright pink, distant from the base of the calyx

6. Leaves orbicular to sub-orbicular, base deeply cordate *c.* 1/3 of leaf length

7. Leaves thick and stiff, lower surface tomentose (Pingelly–Narrogin) ..... **L. rotundifolium**

7: Leaves thin and pliable, lower surface with scattered stellate hairs (Dandaragan) ..... **L. rupicola**

6: Leaves narrowly to broadly ovate, base slightly to moderately cordate < 1/4 of leaf length

8. Leaves thick and stiff; margin strongly recurved to inrolled

9. Inflorescence compact, 19–50 mm long; calyx lobes 2–2.6 mm wide, mauvish pink with dark red to red at the base and centre of each lobe (Wongan Hills–Newdegate) ..... **L. molle**

9: Inflorescence loose, (21–)35–74 mm long; calyx lobes 1.3–2.1 mm wide, mauvish pink with dark red at the base only (N of Badgingarra–Toodyay) ..... **L. decoratum**

8: Leaves thin and pliable; margin slightly to moderately recurved

10. Lower leaf surface with a mix of small stellate hairs and occasional larger stellate hairs (Darling Ra. E of Perth–Dryandra)..... **L. bracteatum**

10: Lower leaf surface with occasional larger stellate hairs only (Perth–Augusta; Tarin Rock)..... **L. membranaceum**

4: Epicalyx bracts non-petaloid, linear or narrowly oblong

11. Scale-like petals present

12. Outer calyx and ovary with stellate and glandular hairs (ovary sometimes with glandular hairs only) (E of Hopetoun–Israelite Bay)..... **L.** sp. **Mt Ragged***

12: Outer calyx and ovary with stellate hairs only

13. Style with scattered or occasional fan-shaped stellate hairs

14. Mature ovary > 2.5 mm wide (SE WA, southern SA, Vic, NSW) ..... **L. behrii***

14: Mature ovary < 2 mm wide

15. Inflorescence a cyme of 3–9 flowers, each flower > 6 mm long (Bodalin–Albany –Cocklebiddy)..... **L. rosmarinifolium ***

15: Inflorescence a cyme of 8–15 flowers, each flower < 6 mm long (Stirling Range NP–Howick Hill) ..... **L. parviliflorum***

13: Style with a dense conical mass of fan-shaped stellate hairs

16. Leaves narrowly oblong, narrowly ovate to ovate or elliptic, usually > 3 mm wide

17. Apical leaves erect; upper surface rusty-brown from an indumentum of dense, rusty orange stellate hairs, late-glabrescent (Carnamah–SE of Mullewa)..... **L.** sp. **Watheroo**

17: Apical leaves usually horizontal or reflexed; upper surface greyish green from an indumentum of tomentose, white stellate hairs with dark brown centres, early-glabrescent (Cataby–S of Geraldton)..... **L. drummondii**

16: Leaves linear (L:W >10:1), usually < 2.5 mm wide

18. Flowers pink; calyx lobe < 1 mm wide at the base (Walkaway–Gingin)..... **L. lineare**

18: Flowers greenish white; calyx lobe > 2 mm wide at the base (Bodalin–Albany–Cocklebiddy) ..... **L. rosmarinifolium***

11: Scale-like petals absent

19. Leaves linear (L:W > 10:1) to narrowly oblong usually ≤ 2.5 mm wide (Chiddarcooping NR–Boxwood Hill) ..... **L. fitzgibbonii**

19: Leaves narrowly ovate to ovate or elliptic, usually > 3 mm wide

20. Trailing subshrub; stem and outer calyx indumentum of scale-like hairs; leaves usually < 6 mm long (Bindoon–Toodyay; NE of North Bannister) ..... **L. caroliae**

20: Erect subshrub to shrub; stem and outer calyx indumentum of multiangulate stellate hairs; leaves > 6 mm long

21. Leaves always multilobed; ovary and fruit winged between carpel fusion lines (Serpentine NP) ..... **L. pterocarpum**

21: Leaves entire, sinuate, trilobed or multilobed; ovary and fruit not winged

22. Lower leaf surface glabrous or with scattered to moderately dense stellate hairs with arms > 0.2 mm long

23. Leaves thickened and firm; lower leaf surface glabrous or with scattered, stellate hairs on veins only (Bullsbrook–North Bannister). ..... **L. glabratum**

23: Leaves thin and pliable; lower leaf surface with a scattered to moderately dense indumentum of stellate hairs

24. Indumentum of pale brown, golden or ferruginous (rarely purple-red), stellate hairs present on new growth of the stem, pedicels and peduncle; calyx lobes 0.7–1.1 mm wide, base dark red

25. Leaves entire, multilobed or sinuate; inflorescence usually with ≥ 10 flowers (Bullsbrook –Walpole–Boat Harbour) ..... **L. floribundum**

25: Leaves always distinctly trilobed; inflorescence always with < 10 flowers (Margaret River region) ..... **L. occidentale**

24: Indumentum of bright red, stellate hairs (on new growth); calyx lobes 1.4–2.3 mm wide, base dark red with green at junction of lobes

26. Lower leaf surface with two layers of stellate hairs (large and small); calyx lobes 1.4–1.7 mm wide, inner surface with stellate hairs; aril a cream-brown cap with 2–5 arms, 1.6–2.3 mm long (Kellerberrin–Kwolyin) ..... **L. moullean**

26: Lower leaf surface with one layer of large stellate hairs; calyx lobes (1.7–)2–2.8 mm wide, inner surface glabrous; aril a white cap with 2 arms, *c.* 1.3 mm long (Mt Lesueur) ..... **L. rutilans**

22: Lower leaf surface with a dense tomentum of stellate hairs, each with short arms < 0.2 mm long

27. Leaves usually < 20 mm long; calyx lobes 1.5–2.6 mm wide

28. Inflorescence loose, 23–41 mm long; one epicalyx bract

29. Flowers bright pink; occurs in jarrah-marri woodland on laterite (Boddington–Cranbrook) ..... **L. cardiophyllum**

29: Flowers white or with a pale pink tinge; occurs in open mallee in loamy sand (Wellstead) ..... **L.** sp. **Wellstead**

28: Inflorescence compact, 13–20 mm long; three epicalyx bracts (Brookton) ..... **L.** sp. **Weam Reserve**

27: Leaves > 25 mm long; calyx lobes 2.6–4.5 mm wide

30. Leaves ovate, apices acute; inflorescence compact; calyx lobes 3.5–4.5 mm wide (Dudinin–Lake Muir–Two Peoples Bay) ..... **L. cordifolium**

30: Leaves narrowly ovate to ovate, apices acuminate; inflorescence becoming loose; calyx lobes 2.6–3.4 mm wide (Mt Frankland–Stirling R.–N of Two Peoples Bay) ..... **L.** sp. **Denmark**

1: Style upper 1/2 to 2/3 glabrous (base of style may have sessile stellate hairs)

31. Anthers > 3 mm long with an acuminate (rostrate) apex

32. Petals present (Whicher Range) ..... **L. laxiflorum**

32: Petals absent

33. Epicalyx bracts towards base of pedicel; calyx lobes narrowly ovate; anthers densely stellate-hairy (Northam) ..... **L. trichantherum**

33: Epicalyx bracts towards base of calyx; calyx lobes ovate; anthers glabrous

34. Calyx outer surface not viscid, with a moderately dense stellate indumentum throughout; bracts filiform, > 6 mm long, < 0.3 mm wide; epicalyx bracts 6–14 mm long

35. Leaves ovate, upper surface prominently rugose and persistently stellate hairy; ovary with papillose glands (New Norcia) ..... **L. cenobium**

35: Leaves trilobed, upper surface smooth, glabrescent; ovary with dense white stellate hairs (Boonanarring NR) ..... **L. venustum**

34: Calyx outer surface viscid with dense globular glands, sometimes also with white stellate hairs at the base; bracts very narrowly ovate or very narrowly oblong < 6 mm long, > 0.3 mm wide; epicalyx bracts 3.3–9 mm long

36. Leaves usually trilobed; pedicel and calyx outer surface with dense globular glands only or rarely also with scattered white stellate hairs at the base of the calyx (Darling Scarp) ..... **L. glutinosum** subsp. **glutinosum**

36: Leaves ovate or shallowly trilobed; pedicel and calyx outer surface with dense globular glands and with a moderately dense to dense stellate indumentum at the base of the calyx (Moora–Boddington)[1] ..... **L. glutinosum** subsp. **latifolium**

31: Anthers < 3 mm long with an obtuse or sub-acute apex

37. Leaves narrowly oblong to oblong or narrowly ovate to ovate, ≥ 3 mm wide

38. Leaves at apical nodes opposite to sub-opposite, with lower leaves alternate (Kalbarri–Murchison Gorge) ..... **L. oppositifolium***

38: Leaves all alternate

39. Epicalyx bracts oblong, (1–)1.8–2.4 mm wide, strongly fused at base

[1]In areas where the distributions of the two subspecies overlap these diagnostic characters may intergrade (see Shepherd & Wilkins 2015).

40. Leaf surface slightly rugose, margin sinuate; indumentum of stellate hairs only (southern coastal WA, SA, Vic, Tas) ..... **L. discolor**

40: Leaf surface smooth, margin entire; indumentum a mix of stellate and glandular hairs to 0.7 mm long (Fitzgerald River NP) ..... **L. adenotrichum**

39: Epicalyx bracts narrowly oblong, narrowly ovate or filiform, 0.3–1.6 mm wide, slightly fused to free at base

41. Petals with a dense to tomentose indumentum of stellate hairs

42. Leaves ovate to hastate, margin flat; epicalyx bracts usually > calyx length; ovary 2-locular (E of Geraldton–Watheroo NP) ..... **L.** sp. **Coorow**

42: Leaves ovate, margin recurved to concave; epicalyx bracts < calyx length; ovary 3-locular (Kalbarri–W of Mullewa) ..... **L. oldfieldii**

41: Petals glabrous or with a few scattered stellate hairs only

43. Ovary papillate otherwise glabrous (Stirling Ra.–East Mt Barren) ..... **L. monticola**

43: Ovary stellate hairy, or with a mix of stellate and glandular hairs

44. Inflorescence a loose cyme with flowers well-spaced

45. Leaves with a distinctly acute to acuminate apex

46. Inflorescence 25–30(–50) mm long; peduncles to 25 mm long; flowers 4–6(–9); ovary stellate-hairy (Stirling Ra.) ..... **L. dielsii**

46: Inflorescence 65–85 mm long; peduncles to 50 mm long; flowers 7–15; ovary glandular and stellate-hairy (Stirling Ra.) ..... **L. membraniflorum**

45: Leaves with an obtuse or sub-acute apex

47. Pedicels > 3.5 mm long; inner calyx bright pink (Dandaragan–S of Geraldton) ..... **L. ogilvieanum**

47: Pedicels < 3.5 mm long; inner calyx white, cream or pale pink

48. Leaves ovate, *c.* 10–30 mm wide, upper surface glossy and viscid, base strongly cordate (Bremer Bay–Hopetoun) ..... **L. quinquenervium**

48: Leaves narrowly ovate to oblong, *c.* 4.5–13 mm wide, upper surface not glossy or viscid, base petiolate or slightly cordate

49. Calyx outer surface with white stellate hairs (Albany–Israelite Bay) ..... **L. indutum***

49: Calyx outer surface with ferruginous stellate hairs (Cape Le Grande NP) ..... **L. maxwellii**

44: Inflorescence a compact cyme with flowers in close proximity or touching

50. Calyx outer surface with a woolly indumentum of stellate hairs, each with arms to > 0.6 mm long

51. Calyx outer surface with a mix of stellate and glandular hairs, waxy in appearance, inner surface white to cream (Lake King–Forrestania) ..... **L. ferraricollinum**

51: Calyx outer surface with stellate hairs only, not waxy in appearance

52. Calyx inner surface pink

53. Epicalyx bracts shorter than the calyx; calyx inner surface with stellate hairs on the outer margin only with moderately dense glands towards the centre and base (Beaufort Inlet–Cape Arid) ..... **L. compactum**

53: Epicalyx bracts as long as or longer than the calyx; calyx inner surface with stellate hairs only (Albany–Israelite Bay)..... **L. indutum***

52: Calyx inner surface cream or greenish-white (Bodallin–Albany–Cocklebiddy)..... **L. rosmarinifolium***

50: Calyx outer surface and ovary with a close tomentum of stellate hairs, each with arms < 0.4 mm long

54. Flowering ovary > 2.5 mm wide (SE WA, SA, Vic, NSW)..... **L. behrii***

54: Flowering ovary < 2 mm wide

55. Inflorescence a cyme of 8–15 flowers, each calyx < 6 mm long (Stirling Range NP–Howick Hill)..... **L. parviflorum***

55: Inflorescence a cyme of 3–9 flowers, each caylx > 6 mm long

56. Inner calyx pink, lobes with glands present (Ravensthorpe) ..... **L.** sp. **Desmond**

56: Inner calyx whitish green or cream with glands absent (Bodallin–Albany–Cocklebiddy)..... **L. rosmarinifolium***

37: Leaves linear (L:W > 10:1) to narrowly oblong usually ≤ 3 mm wide

57. Outer surface of calyx with stellate and glandular hairs to 0.8 mm long; ovary with both kinds of hairs or only glandular hairs (E of Hopetoun–Israelite Bay)..... **L.** sp. **Mt Ragged***

57: Outer surface of calyx with stellate hairs to 0.15–0.3 mm long, lacking glandular hairs; ovary with stellate hairs only

58. Inflorescence a cyme of 8–15 flowers, each flower < 6 mm long (Stirling Range NP–Howick Hill)..... **L. parviflorum***

58: Inflorescence a cyme of 3–9 flowers, each flower > 6 mm long (Bodallin–Albany–Cocklebiddy)..... **L. rosmarinifolium***

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References

Andrews, H.C. (1802). *The botanist's repository for new, and rare plants* 3: t. 208 (H.C. Andrews: London.)

Bennett, E.M. & Shepherd, K.A. (2007). *Lasiopetalum ferraricollinum* (Malvaceae *s. lat.*: Lasiopetaleae), a new species from the ironstone hills near Forrestania, Western Australia. *Nuytsia* 17: 67–72.

Bentham, G. (1863). *Lasiopetalum*. *Flora Australiensis*. Vol. 1. pp. 259–266. (Reeve & Co.: London.)

Blackall, W.E. & Grieve, B.J. (1974). *How to know Western Australian wildflowers*. Parts I, II, III. (University of Western Australia Press: Perth.)

Blackall, W.E. & Grieve, B.J. (1988). *How to know Western Australian wildflowers* (2nd edition). Part I. (University of Western Australia Press: Perth.)

CHAH (Council of Heads of Australasian Herbaria) (2006–). *National Species List*. https://biodiversity.org.au/nsl/services/apni [accessed 7 February 2018].

Grieve, B.J. (1998). *How to know Western Australian wildflowers.* Pt. 2. (University of Western Australia Press: Crawley, Western Australia.)

Marchant, N.G., Wheeler, J.R., Rye, B.L., Bennett, E.M., Lander, N.S. & Macfarlane, T.D. (1987). *Flora of the Perth region*. Part 1. (Department of Agriculture: Perth.)

Meissner, R.A., Rathbone, D.A. & Wilkins, C.F. (2014). *Lasiopetalum adenotrichum* (Malvaceae *s. lat.*), a new species from Fitzgerald River National Park. *Nuytsia* 24: 65–69.

Orifici, R. (1996). Variation within the *Lasiopetalum rosmarinifolium* (Turcz.) Benth. complex. Botany Honours Thesis. The University of Western Australia.

Shepherd, K.A., Bennett, E.M., Wilkins, C.F. & Sage, L.W. (2006). *Lasiopetalum pterocarpum* (Malvaceae *s.l.*: *Lasiopetaleae*), a new and rare species from south-west Western Australia. *Nuytsia* 16(1): 175–181.

Shepherd, K.A. & Wilkins, C.F. (2015). A revision of species from the tribe *Lasiopetaleae* (Byttnerioideae: Malvaceae) with rostrate anthers. *Nuytsia* 25: 171–189.

Shepherd, K.A. & Wilkins, C.F. (2017). A revision of the *Lasiopetalum floribundum* group (Malvaceae), including recognition of four new species. *Nuytsia* 28: 273–298.

Shepherd, K.A. & Wilkins, C.F. (2018). A taxonomic revision of species with a petaloid epicalyx bract allied to *Lasiopetalum bracteatum* (Malvaceae). *Nuytsia* 29: 161–179.

Smith, J.E. (1798). The characters of twenty new genera of plants. *Transactions of the Linnean Society of London* 4: 216.

Smith, J.E. (1812). *The cyclopaedia or universal dictionary of arts, science and literature*. Rees, A. (ed.). 20(39): LAS. (Longman, Hurst, Rees, Orme & Brown etc.: London.)

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 30 January 2018].

Wheeler, J.R., Marchant, N.G. & Lewington, M. (2002). *Flora of the south west: Bunbury – Augusta – Denmark*. Vol. 2: Dicotyledons. (ABRS: Canberra; University of Western Australia Press: Perth.)

Western Australian Herbarium (1998–). *FloraBase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. https://florabase.dpaw.wa.gov.au/ [accessed 30 January 2018].

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Three new perennial species of *Calandrinia* (Montiaceae) from southern Western Australia

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Abstract

Obbens, F.J. Three new perennial species of *Calandrinia* (Montiaceae) from southern Western Australia. *Nuytsia* 29: 193–204 (2018). Three new species of *Calandrinia* Kunth. sect. *Pseudodianthoideae* Poelln. from Western Australia (*C. quartzitica* Obbens, *C. lefroyensis* Obbens and *C. wilsonii* Obbens) are described and illustrated. All occur in the south-west, where there is only one other perennial species known to date.

Introduction

Whereas a series of recently published papers (Obbens 2011, 2012, 2014a, 2014b) dealt with the taxonomy of new annual species of *Calandrinia* Kunth. from Western Australia, this paper describes three new perennial species. *Calandrinia quartzitica* Obbens and *C. lefroyensis* Obbens are conservation priority species found mainly within samphire communities adjacent to salt lakes of the Eastern Goldfields. The third species, *C. wilsonii* Obbens occurs within similar habitats and is also an uncommon species of the Avon Wheatbelt bioregion. Although these species are perennials, they are not tuberous and therefore are placed within sect. *Pseudodianthoideae* Poelln. One other perennial species, known by the phrase-name *C.* sp. Gypsum (F. Obbens & L. Hancock FO 10/14) also occurs in south-western Australia.

Methods

Methods used are the same as those described in Obbens (2011). The descriptions refer to stem leaves only for *C. quartzitica* and *C. lefroyensis*, as no distinction between basal and stem leaves was observed, the stems usually being quite leafy and sub-fasciculate from near ground level to the stem ends. Occasionally, only the apical portions of stems are leafy in the two taxa, but leaf scars are still evident beneath. If there is a distinct basal leaf whorl, then these leaves may be deciduous prior to flowering and therefore were not seen in the examined collections. *Calandrinia wilsonii* usually has an inconspicuous basal rosette and stem leaves that are more scattered and alternate.

SEM images were produced using a Joel NeoScope JCM-6000 scanning electron microscope, operating at a current of 15Kv with high vacuum. Seeds were coated with gold before scanning. Images were subsequently processed using Photoshop 2.0. The term ‘collicula’ (pl. ‘colliculae’) is used here

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to describe the individual domed protuberances characteristic of a colliculate seed surface pattern commonly seen in many *Calandrinia* species.

The bioregions and sub-bioregions referred to in the text, species distribution statements, and those indicated on the map, are from *Interim Biogeographical Regionalisation for Australia (IBRA) Version 7.0* (Department of the Environment 2013).

Taxonomy

Calandrinia quartzitica Obbens, *sp. nov.*

Type: Goongarrie Lake edge, Western Australia [precise locality withheld for conservation reasons], 10 October 2013, *F. Obbens, F. Hort & J. Hort* FO 18/13 (*holo*: PERTH 08479143 [Sheet 1 of 2] & PERTH 08479151 [Sheet 2 of 2]; *iso*: AD, CANB, MEL).

Calandrinia sp. Goongarrie (F. Obbens, F. Hort & J. Hort FO 18/13), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed November 2017].

Semi-erect to erect *perennial herbs*, usually scrambling through other plants, 150–500 mm tall, 40–350 mm wide, glabrous, the root system comprising a moderate to large taproot with several lateral roots. *Stems* usually 1–7, 14–130 mm long, leafy, radiating from base. *Stem leaves* very fleshy, narrowly linear to narrowly obovate, occasionally broader, 10.7–67 mm long, 1.9–5.5 mm wide, usually terete to compressed in T.S., rarely flatter with a subtle, shallow, medial groove on the adaxial surface, scattered to sub-fasciculate over entire stem or sometimes confined to the stem ends, apex often acute and mucronate, usually reddish-brown. *Scapes* 60–210 mm long, with 2 or more residual leaves and/or bracts evenly scattered along the scape, occasionally once-branched. *Inflorescence axis* 30–110 mm long, bare except for 3 to several ± scarious bracts, mostly opposite particularly on the upper axis, generally forming a loose cyme. *Inflorescence axis bracts* appressed to ± spreading, triangular, occasionally broader, 1.5–3.2 mm long, 1.7–3.1 mm wide, apex long-acuminate. *Pedicels* 7–29 mm long and erect, to 36 mm long in fruit and moderately reflexed. *Flowers* 17–35 mm diam. *Sepals* thick, ovate to broadly ovate, 4.2–6.3 mm long, 3.1–4.7 mm wide, free to base, mucronate, with a moderately prominent midvein and several roughly parallel lateral veins with some reticulation. *Petals* 5, creamy white tinged with pink or entirely light or mid-pink, obovate to broadly obovate, sometimes with a small notch at apex, 8.3–14.2 mm long, 5.5–9.8 mm wide, free to base. *Stamens* 65–96 in 2 or 3 ill-defined rows with the inner series longest; filaments free, 1.4–5.1 mm long, attached to the top of basal ring beneath ovary, papillose on lower half of basal adaxial portion; anthers elliptic to oblong in outline, 0.75–1.1 mm long, 0.5–0.6 mm wide, versatile, extrorse, dehiscing longitudinally. *Ovary* obloid to obovoid, 1.3–2.1 mm diam., brown. *Stigmas* 3, squat-triangular, lengthening, spreading somewhat and becoming narrowly triangular to linear with maturity, 0.9–3.6 mm long, free to base, with a dense covering of moderately long stigma trichomes. *Capsule* ovoid to broadly ovoid, 3.4–6.2 mm long, 2.4–4.4 mm wide, the apex obtuse, usually level with the sepals, occasionally slightly shorter or longer; valves 3, splitting from apex to base with age. *Seeds* 98–209 per capsule with an obvious, bright metallic lustre when mature, reniform, 0.65–0.75 mm long, 0.6–0.7 mm wide, 0.4–0.5 mm thick, surface pattern strongly colliculate, in plan view the surface with elongated and moderately domed colliculi, sometimes each colliculum with a papilla or fingertip-like projection distally, together these papillae or projections forming 3 or more even-swirled rows in plan view and 7 or more parallel rows dorsally. (Figures 1, 2)

Figure 1. *Calandrinia quartzitica*. A – habitat; B – habit, with acute leaf apices arrowed. Photographs by Brian Moyle.

Diagnostic features. *Calandrinia quartzitica* may be uniquely diagnosed among Western Australian species by the following combination of characters: perennial and scrambling habit; seeds with an obvious, bright metallic lustre at maturity; terete, mostly linear leaves with acute apices; an unusual habitat dominated by quartzite or at least grows in soils wholly or in part derived from quartz.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 28 Sep. 2003, *R. Davis* 10635 (PERTH); 13 Oct. 2016, *F. Hort, J. Hort & F. Obbens* FH 4097 (PERTH); 13 Oct. 2016, *F. Hort, J. Hort & F. Obbens* FH 4101 (PERTH); 20 Sep. 2013, *J. Jackson & B. Moyle* 271 (PERTH); 8 Oct. 2014, *F. Obbens & L. Hancock* FO 05/14 (PERTH); 15 Oct. 2015, *F. Obbens, F. Hort & J. Hort* FO 24/15 (PERTH); 16 Oct. 2015, *F. Obbens, F. Hort & J. Hort* FO 26/15 (PERTH).

Phenology. Flowering and fruiting collections of *C. quartzitica* have been made from mid-September to mid-October, but the actual period is likely to be longer.

Distribution and habitat. *Calandrinia quartzitica* is currently known from the edge of five salt lakes just north of Kalgoorlie in the Eastern Murchison sub-bioregion (Figure 3). It occurs on the samphire-dominated lake edges and lake channels, and at the base and runoff flats of closely adjacent quartzitic ridges and breakaways or quartzitic hummocky ground, where these occur near salt-lake edges. On the salt-lake flats the soils are brown silty sand or red-brown silty loams strewn with quartzite pieces, while the nearby ridges and breakaway slopes are very rocky with residual soil pockets. At locations where there are no obvious quartzitic ridges or hummocks it grows on lake edge floodplains in red-brown silty sand derived wholly or in part from pre-existing quartz geology, as seen from the Geological Survey of Western Australia, 1:250,000 Geological Series maps (Kriewaldt 1970, Thom & Barnes 1977). On these lake edge flats *C. quartzitica* usually grows through samphire shrubs using them as support. The samphire community includes some of the following: *Atriplex codonocarpa*,

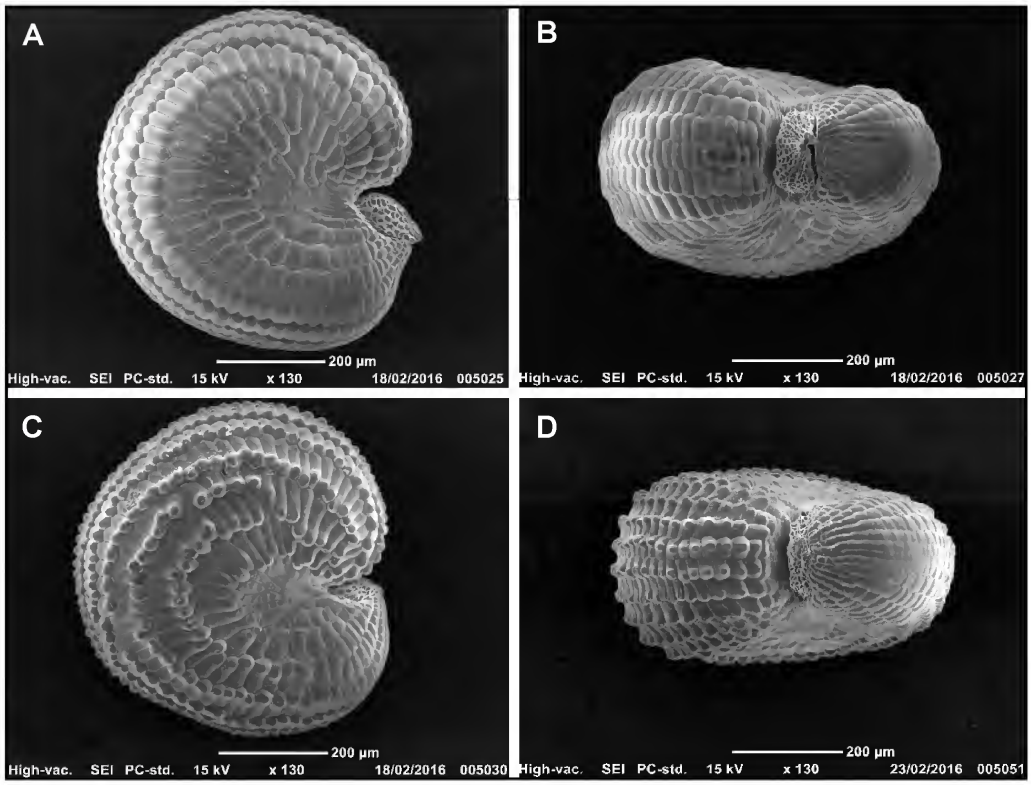

Figure 2. *Calandrinia quartzitica* seeds from the type location at Lake Goongarrie (A, B) and from Lake Moriarty (C, D). A – plan view; B – dorsal view; C – plan view; D – dorsal view.

Maireana amoena, *M. glomerata*, *Lawrencia squamata*, *Tecticornia* sp., *Eremophila glabra* subsp. *verrucosa*, *Frankenia* sp., *Disphyma crassifolium*, *Eragrostis dielsii* and *Brachyscome ciliaris*. Ridge sites generally comprise open shrublands of *Eremophila oppositifolia*, *Scaevola spinescens*, *Ptilotus rigidus* etc. with a mulga species dominating the ridgetops and breakaway summits.

Conservation status. Listed by Smith and Jones (2018) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australia Flora, under the name *Calandrinia* sp. Goongarrie (F. Obbens, F. Hort & J. Hort FO 18/13). *Calandrinia quartzitica* is a medium-range endemic that has evolved within an unusual habitat type. The combination of salt lakes and samphire flats next to quartzite geology is relatively uncommon and it is probable that this species will only be found at locations that have similar geology. There are eight collections of *C. quartzitica* at PERTH over a range of approximately 150 km north to south, but not all are from different populations and there are no records from any conservation areas. Several lake systems occur in the general area, and searches for more populations of *C. quartzitica* should be undertaken there.

Etymology. The epithet is derived from the quartz geology that exists at sites where this species has been collected. It not only refers to the obvious associated landscape features such as quartzitic ridges and quartzitic hummocks, but also to flatter terrain where this species grows in soils wholly or in part derived from quartz or quartz-related geology.

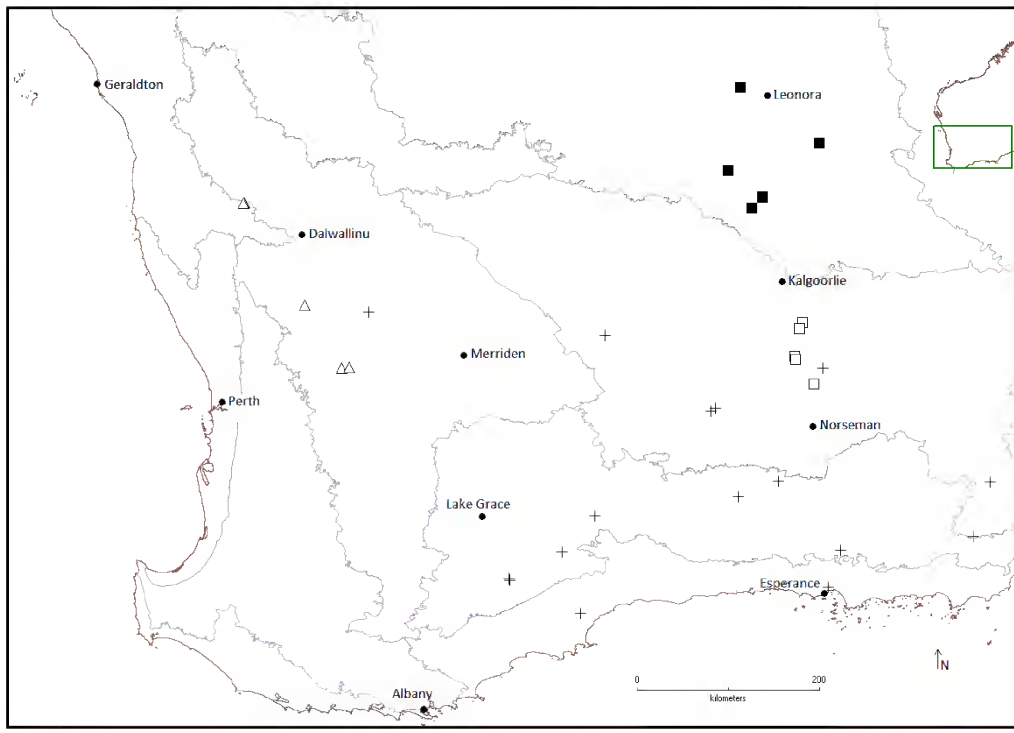

Figure 3. Distribution of *Calandrinia quartzitica* (■), *Calandrinia lefroyensis* (□), *Calandrinia wilsonii* (Δ) and *Calandrinia* sp. Gypsum (F. Obbens & L. Hancock FO 10/14) (+).

Affinities. Previously (see notes below) *C. quartzitica* has been confused with *C. polyandra* Benth., which differs in being an erect annual species, with less succulent leaves that are more compressed and have very distinct adaxial grooves. However, a recent molecular phylogeny of Australian *Calandrinia* has *C. sculpta* Obbens & J.G.West as sister to *C. quartzitica* (with moderate bootstrap support), while *C. polyandra* is placed some distance away (Hancock *et al.* in press). *Calandrinia sculpta* differs from *C. quartzitica* in being an annual, decumbent species with black seeds, but is somewhat similar in its seeds having dorsal rows of papillae, however, these rows are fewer, well-spaced and with much larger papillae.

Somewhat similar in morphology to *C. quartzitica* is the other new taxon described here, *C. lefroyensis* Obbens. This species was not included in the above molecular analyses. See the affinities section under that species for differences between the two taxa.

Notes. In 2003, R. Davis made the first collection of *Calandrinia quartzitica* under the name *C. polyandra* noting that it was possibly a perennial. It was not collected again until 2013, when J. Jackson and B. Moyle discovered *C. quartzitica* while looking for another conservation-listed species that preferred quartzite ridges. They recognised it as a potentially new species, and not long after it was phrase-named.

Mature seeds of *C. quartzitica* can be readily distinguished by their bright, metallic lustre, but immature seeds may lack this lustre and be more similar in colour to mature seeds of *C. polyandra*. In mature seeds of *C. quartzitica* the rows of papillae on the dorsal surface vary from partially to well expressed and might occasionally be almost absent. Certainly they are not always evident in immature seeds.

Calandrinia lefroyensis Obbens, *sp. nov.*

Type: Lake Lefroy system, Western Australia [precise locality withheld for conservation reasons], 4 November 2013, *F. Obbens & E. Reid* FO 9/05 (*holo*: PERTH 07215606; *iso*: CANB, MEL).

Calandrinia sp. Widgiemooltha (F. Obbens & E. Reid FO 9/05), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed November 2017].

Semi-erect to erect *perennial herbs*, usually scrambling through other plants, 135–260 mm tall, 40–160 mm wide, glabrous, the root system comprising a moderate-sized taproot with a few lateral roots. *Stems* usually 1–4, 10–48 mm long, leafy, radiating from base. *Stem leaves* very fleshy, narrowly obovate to obovate, occasionally broader, 4–31 mm long, 0.8–7.3 mm wide, usually semi-terete to compressed in T.S., occasionally flatter with a subtle, shallow, medial groove on the adaxial surface, scattered to sub-fasciculate over entire stem or sometimes confined to the stem ends, apex often obtuse, usually grey-green. *Scapes* 44–170 mm long, with 2 or more residual leaves and/or bracts evenly scattered along the scape, occasionally 2 scapes arising from a stem end. *Inflorescence axis* 20–115 mm long, bare except for 3 to several ± scarious bracts, mostly opposite particularly on the upper axis, generally forming a loose cyme. *Inflorescence axis bracts* appressed to ± spreading, narrowly triangular to triangular, 1.3–2.9 mm long, 1.3–2.2 mm wide; apex acuminate and shortly mucronate. *Pedicels* 7–22 mm long and erect, to 31 mm long in fruit and moderately to strongly reflexed. *Flowers* 16–23 mm diam. *Sepals* thick, ovate to broadly ovate, 4.7–5.7 mm long, 3.5–5 mm wide, free to base, mucronate, with a prominent midvein and several or less, roughly parallel lateral veins with very little reticulation. *Petals* 5, mid-pink to dark pink, obovate to broadly obovate, sometimes shallowly emarginate at apex, 7.8–10.3 mm long, 5.4–8.5 mm wide, free to base. *Stamens* 119–126 in 3 or 4 ill-defined rows with the inner series longest; filaments free, 1.2–3.1 mm long, attached to the top of basal ring beneath ovary, papillose on lower third of basal adaxial portion; anthers oblong to broadly oblong in outline, 0.6–0.7 mm long, 0.4–0.5 mm wide, versatile, extrorse, dehiscing longitudinally. *Ovary* obovoid, 1.2–1.6 mm diam., brown. *Stigmas* 3, squat, narrowly triangular, lengthening, spreading somewhat and becoming narrowly linear with maturity, 1.2–3.3 mm long, free to base, with a dense covering of long stigma trichomes. *Capsule* ovoid, 3.5–5.2 mm long, 2.6–3.8 mm wide, the apex obtuse, usually level with the sepals occasionally slightly shorter; valves 3, splitting from apex to base with age. *Seeds* 59–72 per capsule, metallic grey, dull, sub-reniform to reniform, 0.6–0.8 mm long, 0.5–0.7 mm wide, 0.45–0.65 mm thick, strongly colliculate, in plan view the surface with very elongated and well-domed colliculi, most with a papilla (i.e. fingertip-like) or a tubercle distally, together these papillae/tubercles forming a few erratic swirled rows in plan view and 4 or 5 distinctly separated, parallel rows in dorsal view. (Figures 4, 5)

Diagnostic features. *Calandrinia lefroyensis* may be uniquely diagnosed among Western Australian species by the following combination of characters: scrambling perennial habit; seeds a distinctive dull, metallic grey at maturity; seeds with a strongly colliculate structure containing very obvious rows of papillae/tubercles; mostly semi-terete to compressed, obovate leaves with obtuse apicies; an unusual habitat on the ecotone of samphire and open woodlands.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons]: 9 Oct. 2014, *F. Obbens & L. Hancock* FO 09/14 (PERTH); 30 Oct. 2015, *G. Owen & P. Moonie* PM 65 (PERTH); 14 Nov. 2016, *G. Wells* RS 089-05 (PERTH); 15 Nov. 2016, *G. Wells* SI0054-01 (PERTH).

Phenology. Based on material seen, *C. lefroyensis* flowers and fruits from early October to mid-November, but a longer flowering/fruiting period is possible.

Figure 4. *Calandrinia lefroyensis* from Lake Cowan. A – habitat; inset – flower. Photographs by Lillian Hancock.

Distribution and habitat. *Calandrinia lefroyensis* occurs on salt-lake flats among samphire communities. It is currently known from three lakes south of Kalgoorlie in the Coolgardie bioregion (see Figure 3). The soils are brown silty loams or brown-grey sandy clays. In general, *C. lefroyensis* appears to favour the outer edges of samphire communities including within the ecotone of adjacent communities where there are open assemblages of taller species such as *Casuarina obesa* and *Eucalyptus* spp. It has also been collected up to several hundred metres from the lake shoreline. Associated species at the known sites include *Atriplex nana*, *Maireana glomerifolia*, *Tecticornia doleiformis*, *Frankenia setosa*, *Senecio pinnatifolius* and *Austrostipa* sp.

Conservation status. Listed by Smith and Jones (2018) as Priority One under Department of Parks and Wildlife Conservation Codes for Western Australian Flora, under the name *Calandrinia* sp. Widgiemooltha (F. Obbens & E. Reid FO 9/05). *Calandrinia lefroyensis*, like *C. quartzitica*, appears to be a medium-range endemic that has evolved around lakes with a similar underlying geology. So far, all known populations are outside conservation estate. Suitable habitat most likely occurs around other lakes in the region and the current distribution probably will be extended locally with targeted surveys.

Etymology. The species is named after Lake Lefroy where it was first collected.

Affinities. *Calandrinia lefroyensis*, *C. quartzitica* and the following described species, *C. wilsonii*, all have flowers with a similar general morphology (having five petals, three stigmas and numerous stamens) to many other species in sect. *Pseudodianthoideae* Poelln. They obviously differ from other species in this section in having distinctive seeds and in being perennials with a scrambling habit. Their distinctive seeds, along with other characters clearly separate them from each other.

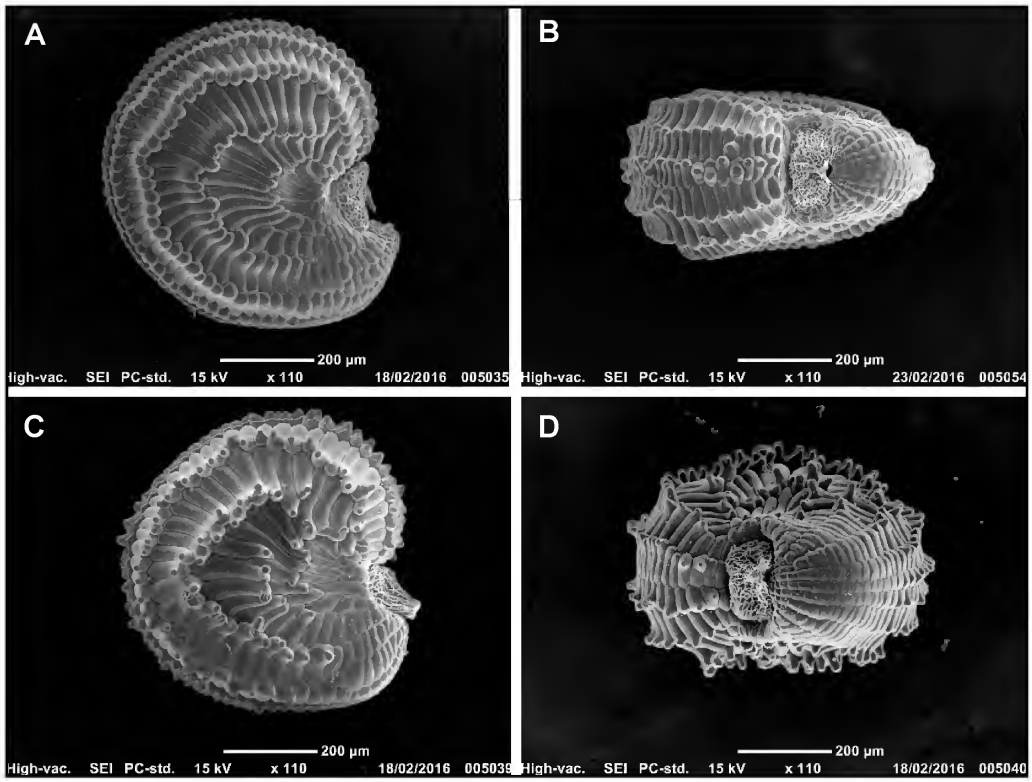

Figure 5. *Calandrinia lefroyensis* seeds from the type locality at Lake Lefroy (A, B) and from Lake Cowan (C, D). A – plan view; B – dorsal view; C – plan view; D – dorsal view.

For example, *C. quartzitica* stem leaves are numerous, mostly terete and linear with an acute apex and often reddish brown, whereas *C. lefroyensis* has somewhat fewer stem leaves that are mostly semi-terete to compressed, narrowly obovate with an obtuse apex and regularly grey-green, and *C. wilsonii* has compressed to more flattened stem leaves that are widely elliptic to obovate and appear light grey to greyish-maroon at maturity. Additionally, *C. lefroyensis* has dull, metallic grey seeds with four or five prominent dorsal rows, whereas mature *C. quartzitica* seeds have a bright, metallic lustre with seven or eight dorsal rows. *Calandrinia wilsonii* differs markedly from both those species in having glossy, brown or tan seeds with a smoother surface, the colliculae being scarcely raised. Its seeds are also non-papillate (see Figures 2, 5, 6).

Notes. While *C. quartzitica* and *C. lefroyensis* both occur on the edges of salt-lake systems of the Eastern Goldfields region the geology of their habitats differs substantially. For instance, north of Kalgoorlie (i.e. within the distribution of *C. quartzitica*) the majority of lake edges consist of alluvial or aeolian deposits often red-brown, silty, quartz sands usually in sheets or dunes and in part also saline and gypsiferous. Also near salt lakes, quartz gabbro is scattered on flats below quartzitic ridges and sometimes even quartz and feldspar from nearby granites (Kriewaldt 1970; Thom & Barnes 1977). This differs markedly to the major geology of salt-lake edges south of Kalgloorie (i.e. within the distribution of *C. lefroyensis*). These areas consist of alluvium and colluvium deposits of semiconsolidated, ferruginous sandstone or metasedimentary rocks and soils such as metaconglomerate, chert and metafelsic volcaniclastic rocks and soils (Griffin 1989). The geology of the agricultural belt where *C. wilsonii* is distributed also contrasts markedly to the above. The

salt lakes and river flats here are generally situated upon granitic and gneissic bedrock covered with shallow assorted deposits. These systems frequently develop wind-blown small rises or lunettes or flats of fine, silty sand or loam, often with significant gypsum content (Chin 1986), and this is where *C. wilsonii* frequently occurs.

Calandrinia wilsonii Obbens, *sp. nov.*

Type: east of Meckering, Western Australia [precise locality withheld for conservation reasons], 28 October 2002, *F. Obbens* 42/02 (*holo*: PERTH 06204457; *iso*: CANB, MEL).

Calandrinia sp. Meckering (F. Obbens 42/02), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed November 2017].

Semi-erect to erect *perennial herbs*; usually scrambling through other plants, 70–370 mm tall, 50–330 mm wide, glabrous, the root system comprising a moderate-sized taproot with several lateral roots. *Basal leaves* fleshy, narrowly spathulate to obovate, 10–72 mm long, 1–11 mm wide, with a shallow medial groove on adaxial surface, green, often insignificant on most specimens. *Stems* usually 1–14, 18–190 mm long, radiating from base. *Stem leaves* very fleshy, elliptic to obovate occasionally linear, 3.5–31.5 mm long, 1.2–7.8 mm wide, usually compressed or more flattened in T.S., alternate, often light grey-maroon when mature. *Scapes* 35–165 mm long, with 2 or 3 residual leaves/bracts evenly spaced, occasionally once-branched. *Inflorescence axis* 20–106 mm long, containing 3 to several ± scarious bracts, mostly opposite on upper axis, generally forming a loose cyme, the surface often finely warty and/or glandular. *Inflorescence axis bracts* appressed to ± spreading, triangular, 1.6–3.5 mm long, 1.4–3 mm wide; apex acute and occasionally recurved. *Pedicels* 9–47 mm long, to 72 mm long in fruit, moderately to strongly reflexed. *Flowers* 15–24 mm diam. *Sepals* thick, ovate to broadly ovate, 3.2–5.8 mm long, 2.9–5 mm wide, free to base, with a indistinct midvein and several, indistinct, parallel lateral veins with some reticulation. *Petals* 5, mid-pink, broadly obovate, with obvious notch or depression at apex, 8.8–11.4 mm long, 7.3–8.9 mm wide, free to base. *Stamens* 65–77 in 2 or 3 ill-defined rows with the inner series longest; filaments free, 1.4–3.5 mm long, attached to top of a basal ring beneath ovary, papillose on lower third of basal adaxial portion; anthers oblong to broadly oblong in outline, 0.8–1.05 mm long, 0.5–0.6 mm wide, versatile, extrorse, dehiscing longitudinally. *Ovary* obovoid, 1.5–2.1 mm diam., brown. *Stigmas* 3, squat-triangular, lengthening, spreading slightly and becoming narrowly triangular to linear with maturity, 1.2–2.1 mm long, free to base, with a dense covering of stigma trichomes. *Capsule* ovoid, 3.3–5.3 mm long, 2.1–3.6 mm wide; apex obtuse, usually equal to or slightly protruding beyond sepals; valves 3, splitting from apex to base with aging. *Seeds* 84–97 per capsule, brown or tan, semi-glossy to glossy, reniform to orbicular, usually with an obvious central depression in plan view, 0.45–0.7 mm long, 0.4–0.6 mm wide, 0.2–0.35 mm thick; surface pattern finely colliculate, the colliculae scarcely raised. (Figure 6)

Diagnostic features. *Calandrinia wilsonii* can be uniquely diagnosed among Western Australian species by the following combination of characters: it is a perennial species with a scrambling habit, it has seeds superficially like *C. polyandra*, but they differ in that the colliculae are smaller, finer and flattened (i.e. not domed). The seeds of this species usually have a central depression on either side in plan view. The inflorescence axis can often be finely warty and/or glandular.

Other specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 26 Sep. 1999, *M.N. Lyons & S.D. Lyons* 3973 (PERTH); 3 Oct. 2000, *M.N. Lyons & S.D. Lyons* 4081 (PERTH); 2 Oct. 2002, *F. Obbens* 37/02 (PERTH); 28 Oct. 2002, *F. Obbens* 43/02 (PERTH); 16 Oct. 2003, *F. Obbens* FO 82/03 (PERTH); 6 Nov. 2015, *F. Obbens* FO 29/15 (PERTH).

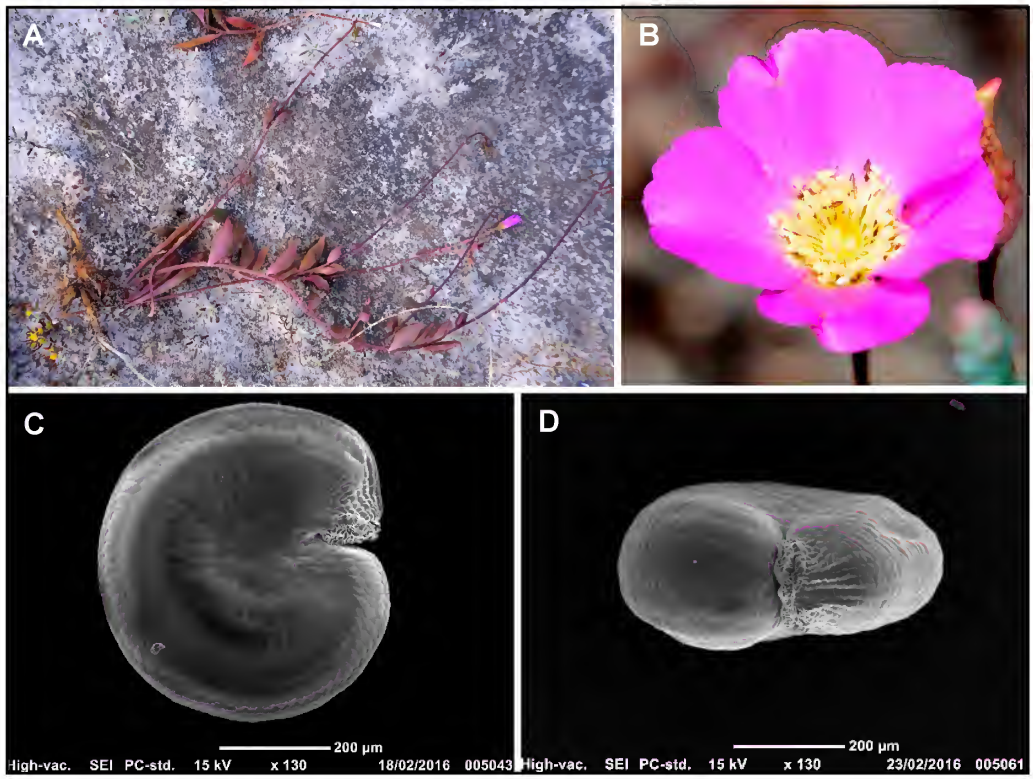

Figure 6. *Calandrinia wilsonii* from Mortlock East River (A, B) and seeds from the type location (C, D). A – habit including rootstock; B – flower; C – plan view; D – dorsal view. Photographs by Lillian Hancock (A) and Jean Hort (B).

Phenology. *Calandrinia wilsonii* flowers and fruits from mid-October through to late November and possibly longer.

Distribution and habitat. This species occurs on small rises or lunettes or flats just above the waterline of salt lakes or saline river floodplains. It has a scattered distribution from near Coorow in the north to east of Meckering (see Figure 3). *Calandrinia wilsonii* grows in a variety of soils frequently described as grey, silty loams/clays to brown or grey-brown, silty sandy clays. Only three collections state that the soil contains gypsum, but it is almost certain that gypsum will be found at some level within these habitats. All collection labels refer to *C. wilsonii* as occurring in samphire or halophytic communities dominated by *Tecticornia* species such as *T. halocnemoides*, *T. leptoclada*, *T. peltata*, *T. undulata* and *T. pergranulata*. Other common species include *Frankenia* sp., *Maireana* sp., *Acacia* sp., *Didymanthus roei*, *Triglochin mucronata*, and often the weed *Mesembryanthemum nodiflorum* and several grassy weeds.

Conservation status. Recently listed as Priority Two under Conservation Codes for Western Australian Flora, as *Calandrinia* sp. Meckering (F. Obbens 42/02). Currently there are seven collections at PERTH from three localities. The distribution is medium-range and it is probably under-collected; however, the low number of plants at most of these sites and the strong impact of salinity and weeds is cause for concern. A targeted survey of 20 or more lakes across and beyond the distribution of *C. wilsonii* during late spring 2015 and 2016 only found one new location with very few plants near Wongan

Hills. This suggests that *C. wilsonii* may be impacted quite severely within the habitat it prefers and more surveys should be undertaken to determine its true conservation status.

Etymology. This species is named in honour of Paul Wilson who has given me taxonomic advice and encouragement with this project over many years. Paul was also responsible for directing me to the site east of Meckering where this species was first discovered. Paul spent most of his working career at the Western Australian Herbarium dedicated to the task of naming and understanding Western Australia's flora.

Affinities. The recent molecular phylogeny of Australian *Calandrinia* (L. Hancock *et al*. in press) has *C. wilsonii* as sister to *C.* sp. Gypsum (F. Obbens & L. Hancock FO 10/14) (100% bootstrap support), while *C. polyandra* is some distance away. However, *C. wilsonii* seeds are similar to those of *C. polyandra*, in size, shape and colour, but differ markedly as the colliculae are smaller, finer, not domed and more-glossy overall. Frequently, the seeds of *C. wilsonii* also differ from *C. polyandra* and other *Calandrinia* species in having a noticeable central depression on either side when in plan view. The inflorescence axis often can be finely warty and/or glandular.

As might be expected from their close relationship, the perennial species *C.* sp. Gypsum (F. Obbens & L. Hancock FO 10/14) is similar in habit and habitat to *C. wilsonii*, hence some confusion between these two species is potentially possible. *Calandrinia* sp. Gypsum (F. Obbens & L. Hancock FO 10/14) differs substantially from *C. wilsonii* in having somewhat glossy, dark red-brown to black seeds that are colliculate and finely papillate at maturity; those of *C. wilsonii* are non-papillate.

See notes under *C. lefroyensis* for differences from the other two described species in this paper.

Notes. At present, the distributions of *C. wilsonii* and *C.* sp. Gypsum (F. Obbens & L. Hancock FO 10/14) are quite different and do not overlap (see Figure 3). There are a number of collections of *Calandrinia* perennials from the Lake Magenta and Lake King areas that are sterile or lack mature seeds. These are now designated as *C.* ? sp. Gypsum (F.Obbens & L. Hancock FO 10/14) until future fieldwork can determine their true identity. A description for *C.* sp. Gypsum (F. Obbens & L. Hancock FO 10/14) is also still in progress.

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References

Chin, R.J. (1986). Geological Survey of Western Australia, 1:250,000 Geological Series. Kellerberrin. Sheet SH50-15. (Australian Government Publishing Service: Canberra.)

Department of the Environment (2013). *Australia's bioregions (IBRA)*. IBRA7, Commonwealth of Australia. http://www.environment.gov.au/land/nrs/science/ibra#ibra [accessed Nov 2017].

Griffin, T.J. (1989). Geological Survey of Western Australia, 1:250,000 Geological Series. 2nd edn. Widgiemooltha. Sheet SH51-14. (Australian Government Publishing Service: Canberra.)

Hancock, L.P., Obbens, F., Moore, A.J., Thiele, K., de Vos, J.M., West, J., Holtum, J.A.M. & Edwards, E. (2018). Phylogeny, evolution, and biogeographic history of *Calandrinia* (Montiaceae). *American Journal of Botany*, in press.

Kriewaldt, M. (1970). Geological Survey of Western Australia, 1:250,000 Geological Series. Menzies. Sheet SH51-5. (Australian Government Publishing Service: Canberra.)

Obbens, F. (2011). Five new species of *Calandrinia* (Portulacaceae) from Western Australia with additional information on morphological observations. *Nuytsia* 21(1): 1–23.

Obbens, F. (2012). Three new species of *Calandrinia* (Portulacaceae) from the Eremaean and South West Botanical Provinces of Western Australia. *Nuytsia* 22 (6): 351–362.

Obbens, F. (2014a). Two new species of *Calandrinia* (Portulacaceae) from southern Western Australia. *Nuytsia* 24: 37–43.

Obbens, F. (2014b). *Calandrinia butcherensis* and *C. rubrisabulosa* (Portulacaceae), new species from the Midwest of Western Australia. *Nuytsia* 24: 207–214.

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed November 2017].

Thom, R. & Barnes, R.G. (1977). Geological Survey of Western Australia, 1:250,000 Geological Series. Leonora. Sheet SH51-1. (Australian Government Publishing Service: Canberra.)

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SHORT COMMUNICATION

Hydrocotyle asterocarpa, *H. decorata* and *H. perforata* (Araliaceae), three new Western Australian species with spicate inflorescences

Three new species of *Hydrocotyle* L. from the south-west of Western Australia are described and illustrated herein. All three species differ from most members of the genus in being annuals with spicate inflorescences (rather than umbellate) and highly ornate fruits with prominently lobed or raised dorsal and lateral ribs. Their close relationship with the widespread Australian species *H. medicaginoides* Turcz. is discussed and a key is provided. All three species have conservation priority.

Key to annual species of *Hydrocotyle* with spicate inflorescences

1. Schizocarps with 6 wing-like lobes developing from the dorsal and lateral ribs

2. Wings spreading, orbicular, margins rugulose ..... **H. medicaginoides**

2: Wings ascending above fruiting styles, shape and margins not as above

3. Wings becoming inflated at maturity, margins entire or shallowly lobed ..... **H. asterocarpa**

3: Wings flattened at maturity, marginal lobing undulate to finger-like ..... **H. decorata**

1: Schizocarps with 2 slender wings along the dorsal ribs, lateral ribs raised ..... **H. perforata**

Hydrocotyle asterocarpa A.J.Perkins, *sp. nov.*

Type: saline lake east of Scaddan, Western Australia [precise locality withheld for conservation reasons], 20 October 2017, *A.J. Perkins* AJP-WA 140 (*holo*: PERTH 08935068; *iso*: AD, CANB, MEL, NSW).

Hydrocotyle sp. Truslove (M.A. Burgman 4419), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 13 October 2017].

Annual herbs with a basal rosette of leaves and branched stems bearing leaves and dense spicate inflorescences, 2–6 cm high, 2–15 cm wide. *Stems* erect (in smaller plants) to decumbent (in larger plants), light green to reddish green, terete, villous. *Stipules* white, ovate to linear lanceolate, 1.5–4.0 mm long, 0.5–2.5 mm wide, membranous, translucent, fimbriate along margins. *Petioles* 5–45(–50) mm long, light green, villous. *Leaf blades* simple, dorsiventral, carnose, rhombic to trilobed in juvenile leaves, trilobed to pedately lobed in mature leaves, 4–12 mm long, 4–18 mm wide; adaxial surface glabrous to subglabrous to puberulous, light green to yellowish green; abaxial surface slightly lighter in colour than adaxial, subglabrous to puberulous. *Leaf margins* toothed; teeth rounded to obtuse, glabrous to occasionally tipped with acute hairs. *Median leaf lobes* elliptic to obovate, 4–11 mm long, 3–8 mm wide, with 1–3 marginal teeth. *Lateral leaf lobes* 4–11 mm long, 3–10 mm wide, with 2–9 marginal teeth, incised into 2 asymmetrical lobules in pedate leaves; leaf sinuses 10–90% of lateral lobe length. *Inflorescences* spicate, leaf-opposed, 8–24-flowered. *Peduncles* terete, longer than subtending leaf, 5–25 mm long, villous. *Involucral bracts* absent. *Rachis* 4–16 mm long. *Pedicels* light

https://florabase.dpaw.wa.gov.au/nuytsia/
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green, 0.1–0.2 mm. *Flowers* all hermaphrodite, protandrous, densely arranged along the rachis. *Sepals* absent. *Petals* 5, cream to light creamy yellow, ovate, 0.8–1.0 mm long, 0.5–0.6 mm wide. *Filaments* light cream, 0.5–0.6 mm long. *Anthers* creamy yellow to crimson, elliptic, 0.3 mm long. *Ovaries* light green at anthesis, orbicular to obovate, dorsal and lateral ribs lobed towards their apices. *Schizocarps* bilaterally flattened, symmetrical, broadly obovate, 6 prominent wings developing on the apical lobing of the dorsal and lateral ribs, light green during early development turning creamy brown at maturity and often remaining persistent on the carpophore beyond the senescence of the plants; commissure 85–95% the length of mericarps (excluding the wings). *Mericarps* minutely colliculate, 1.0–1.5 mm long, 1.0–1.3 mm wide; dorsal and lateral ribs raised along the basal half with prominent wings at their apices; wings 0.4–0.9 mm long, ascending well above the fruiting styles, ovate to oblong, margins entire or with shallow lobing, apices often falcate with obtuse to acute tips, wings often enlarging, becoming inflated at maturity; mericarp surface between dorsal and lateral ribs appearing pitted due to raised reticulate ridges; surface between lateral ribs and median ribs similarly covered by raised reticulate ridges; mature mericarps remaining persistent to the carpophore beyond the senescence of the plants. *Carpophores* persistent, acerose. *Fruiting styles* swollen at the base, 0.6 mm long, reflexed. *Cotyledons* oblong in the seedlings. (Figure 1)

Diagnostic features. *Hydrocotyle asterocarpa* can be distinguished from all other taxa in *Hydrocotyle* by possessing the following combination of characters: annual herbs with dense spicate inflorescences; schizocarps star-like due to 6 prominent wings that ascend well above the fruiting styles and are formed from apical lobing of the dorsal and lateral ribs; mericarp wings often enlarging and becoming inflated at maturity; mericarp surfaces appearing pitted due to raised reticulate ridges between the dorsal, lateral and median ribs; mature mericarps remaining persistent to the carpophore (and the infructescences remaining intact) beyond the senescence of the plants; carpophores acerose and persistent (Figure 1A–C).

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] Oct. 1984, *M.A. Burgman* 4419 (PERTH); 5 Sep. 1984, *M.A. Burgman & C. Layman* MAB 3461 (PERTH); 29 Nov. 2007, *J.A. Cochrane & B. Davis* JAC 6924 (K, PERTH); 22 Sep. 1992, *G.F. Craig* 2166 (PERTH); 11 Oct. 2000, *G.J. Keighery & N. Gibson* 5362 (PERTH); 13 Oct. 2007, *A.J. Perkins s.n.* (NSW, PERTH 08048576, SYD); 20 Oct. 2017, *A.J. Perkins* AJP-WA 141 (PERTH); 23 Oct. 2005, *C.D. Turley* 134/1005 (PERTH); 16 Sep. 2011, *C.D. Turley & R.M. Hoggart* 1/911 (PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from September to early November.

Distribution and habitat. *Hydrocotyle asterocarpa* is currently known from areas north of Esperance, around Scaddan and eastward towards Mt Ney, all within the Mallee bioregion (Western Australian Herbarium 1998–) (Figure 2). Plants grow in sandy loam soils surrounding the margins of inland salt lakes, in low open shrubland, often in sheltered positions around mature plants of *Tecticornia* and *Frankenia* spp. (Figure 1D).

Conservation status. *Hydrocotyle asterocarpa* is listed by Smith and Jones (2018) as Priority Two under Conservation Codes for Western Australian Flora, under the name *H.* sp. Truslove (M.A. Burgman 4419). This species is known from several general localities around Scaddan, scattered eastward for about 55 km (Figure 2).

Etymology. The epithet *asterocarpa* is derived from the Greek *astero-*, 'starry', and *-carpus*, 'fruit or seed', in reference to the star-shaped schizocarps of this species (Figure 1B, C). The common name 'Starry Pennywort' is here suggested.

Figure 1. *Hydrocotyle asterocarpa*. A – flowering plants *in situ*, B – infructescence with developing schizocarps bearing winged lobes, C – lateral view of a mature schizocarp showing winged lobes and pitted mericarps surface; D – typical habitat. Scale bars = 1 cm (A), 1 mm (B, C). Vouchers: *A.J. Perkins* AJP-WA 140 (A, D), *J.A. Cochrane & B. Davis* JAC 6924 (B, C). Photographs by A. Perkins.

Affinities. *Hydrocotyle asterocarpa* is morphologically similar to the widespread Australian winter annual, *H. medicaginoides* (Figure 3), and the two rare Western Australian annuals, *H. decorata* A.J.Perkins and *H. perforata* A.J.Perkins, due to all four species possessing dense spicate inflorescences, subsessile flowers, schizocarps with prominent dorsal and lateral ribs that are often lobed or winged

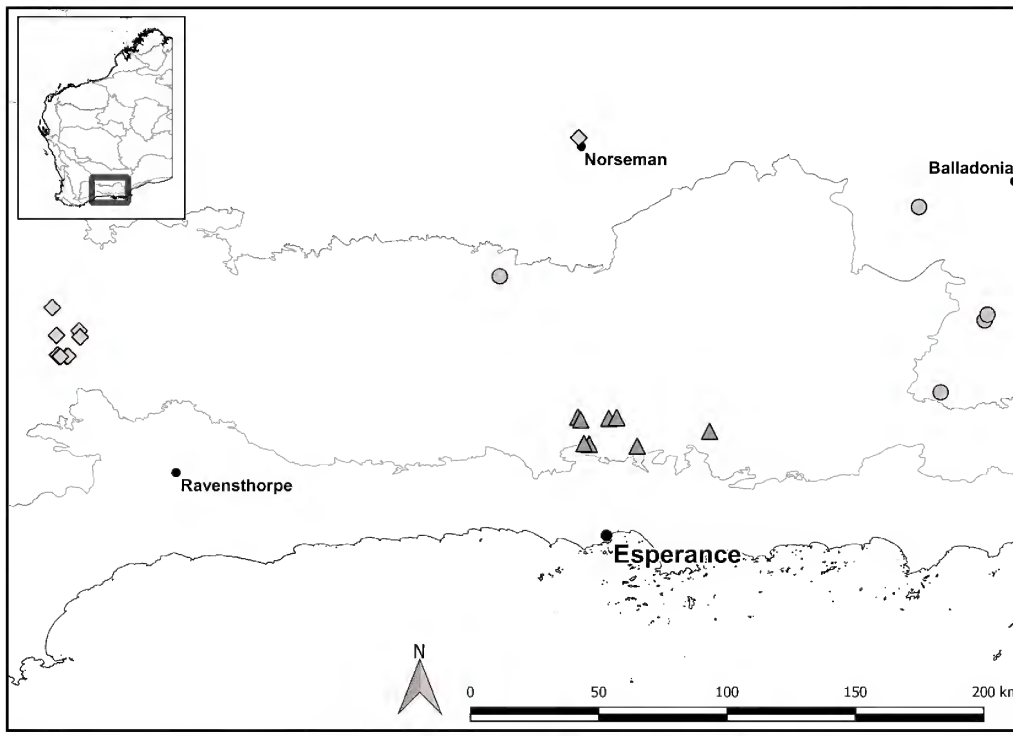

Figure 2. Distribution of *Hydrocotyle asterocarpa* (▲), *H. decorata* (◆) and *H. perforata* (●) based on selected specimens held at CANB, MEL and PERTH. Map with *Interim Biogeographic Regionalisation for Australia* version 7 bioregions (Department of the Environment 2013) shown in grey. Overview map for Western Australia shown in the top left corner.

at maturity, mericarp surfaces ornamented with reticulate ridges and pits (Figures 3–5), and persistent carpophores. The mature mericarps in all four species also remain attached to their carpophores beyond the senescence of the plants in late spring to early summer.

The inflorescence of *H. medicaginoides* has been previously interpreted as being umbellate (Duretto 1999), but with the disarticulation of the mericarps (or removal of the mericarps from the infructescence) it is revealed to be predominantly spicate in structure. Small plants of *H. medicaginoides* may produce umbellate inflorescences (of 3–5 flowers) due to low flower numbers, but most plants typically produce dense spicate inflorescences of 6–12 flowers, like those in *H. asterocarpa*, *H. decorata* and *H. perforata* (Figures 1, 3–5).

Both *H. asterocarpa* and *H. medicaginoides* are known to occur in similar habitats, preferring sites around saline lakes or saline coastal swamps, often associated with low chenopod shrublands (Figures 1D, 3D) and have been found growing sympatrically around Scaddan in Western Australia (Western Australian Herbarium 1998–; AVH 2017). *Hydrocotyle asterocarpa* can be readily distinguished from *H. medicaginoides* based on differences in the schizocarp morphology. Primarily, the schizocarp wings in *H. asterocarpa* ascend well above the fruiting styles, with the margins entire or occasionally with shallow lobing and the apices often falcate with obtuse to acute tips (Figure 1B, C). In *H. medicaginoides*, the wing-like lobes are spreading (not ascending), rugulose along the margins and orbicular in shape (Figure 3B, C). Overall, the ascending wings in *H. asterocarpa* give the dense spicate infructescences in this species a spiky or 'prickly' appearance (Figure 1A–C), whereas the infructescences in *H. medicaginoides* are more spherical to elliptic in profile (Figure 3A, B).

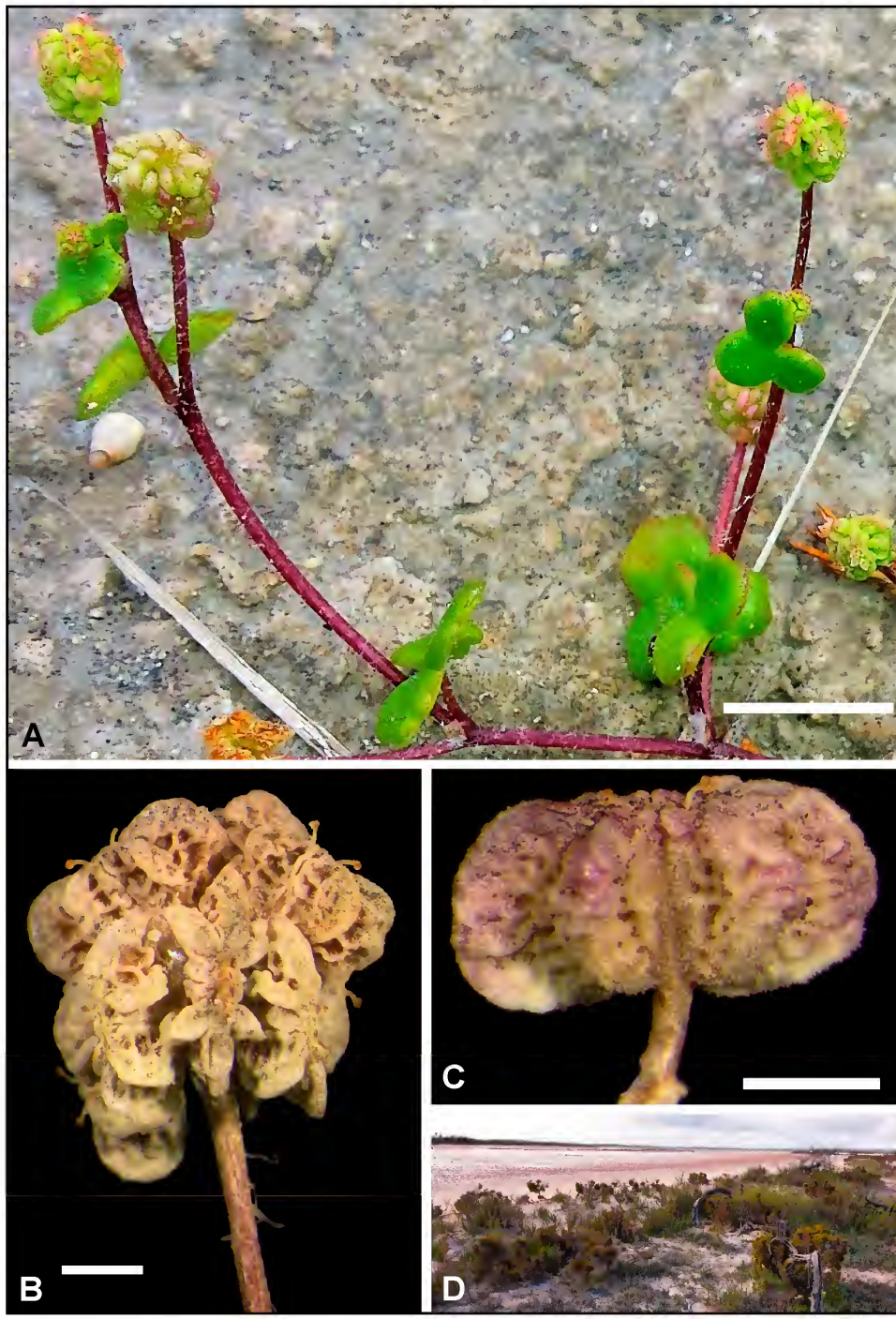

Figure 3. *Hydrocotyle medicaginoides*. A – portion of flowering plant *in situ* showing dense spicate inflorescences and infructescences; B – spicate infructescence with mature schizocarps; C – lateral view of a mature schizocarp showing wing-like lobes with rugulose margins and pitted mericarp surfaces; D – typical habitat. Scale bars = 5 mm (A); 1 mm (B, C). Voucher: *A.J. Perkins* AJP-WA 125 (A, B, C). Photographs by A. Perkins.

Hydrocotyle decorata A.J.Perkins, *sp. nov.*

Type: Lake King, Western Australia [precise locality withheld for conservation reasons], 22 October 2017, *A.J. Perkins* AJP-WA 144 (*holo*: PERTH 08935033; *iso*: AD, CANB, MEL, NSW).

Hydrocotyle hexaptera H.Eichler ms, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 13 October 2017].

Hydrocotyle sp. Hexaptera (T. Erickson TEE 173), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 13 October 2017].

Annual herbs with a basal rosette of leaves and branched stems bearing leaves and spicate inflorescences, 1–4 cm high, 2–30 cm wide. *Stems* decumbent, straight to sinuous, light green to crimson, terete, villous. *Stipules* white, lanceolate to linear lanceolate, 1.0–4.0 mm long, 0.5–2.2 mm wide, membranous, translucent, finely fimbriate along margins. *Petioles* 5–40(–50) mm long, light greenish yellow to reddish green, villous. *Leaf blades* predominantly simple or occasionally compound, dorsiventral, carnose, rhombic to trilobed in juvenile leaves, trilobed to pedately lobed in mature leaves or sometimes trifoliolate, 4–20 mm long, 6–30 mm wide; adaxial lamina surface glabrous or subglabrous to puberulous, light green to yellowish green; abaxial lamina surface slightly lighter in colour than adaxial, subglabrous to puberulous. *Leaf margins* toothed; teeth rounded to obtuse, glabrous to occasionally tipped with short acute hairs. *Median leaf lobes* elliptic to obovate, 4–18 mm long, 3–12 mm wide, with 1–6 marginal teeth. *Lateral leaf lobes* 3–18 mm long, 3–15 mm wide, 3–9 marginal teeth, incised into 2 asymmetrical lobules in pedate leaves; leaf sinuses in simple leaves 10–95% of lateral lobe length. *Inflorescences* leaf-opposed, spicate, 6–26-flowered. *Peduncles* terete, longer than subtending leaves, 4–45 mm long, villous. *Involucral* bracts absent. *Rachis* 3–10 mm long. *Pedicels* light green, 0.1–0.2 mm long. *Flowers* all hermaphrodite, protandrous, densely arranged along the rachis. *Sepals* absent. *Petals* 5, predominantly cream to light creamy yellow with light crimson on the abaxial surface towards the apex, ovate, 0.8–1.0 mm long, 0.5–0.6 mm wide. *Filaments* light cream, 0.6 mm long. *Anthers* predominantly crimson to occasionally creamy yellow, elliptic, 0.3 mm long. *Ovaries* light green at anthesis, orbicular, dorsal and lateral ribs lobed towards their apices. *Schizocarps* bilaterally flattened, symmetrical, broadly obovate, 6 prominent wings developing on the apical lobing of the dorsal and lateral ribs, light green during early development turning creamy brown at maturity; commissure 90–95% the length of mericarps (excluding the wings). *Mericarps* minutely colliculate, 1.2–1.5 mm long, 0.9–1.2 mm wide; dorsal and lateral ribs raised with prominent wings along the entire length of the ribs; wings 0.3–1.0 mm long, ascending with undulate to obtusely lobed margins appearing finger-like with lobes variable in length and number along margin, wings remaining flattened at maturity; mericarp surface between dorsal and lateral ribs with 2 rows of pits either side of a raised undulate ridge running in parallel with the lateral rib; surface between lateral ribs and median ribs similarly with 2 rows of pits either side of a raised undulate ridge running alongside the lateral rib. *Carpophores* persistent, acerose. *Fruiting styles* swollen at the base, 0.5 mm long, reflexed. *Cotyledons* lanceolate in the seedlings. (Figure 4)

Diagnostic features. *Hydrocotyle decorata* can be distinguished from all other taxa in *Hydrocotyle* by possessing the following combination of characters: decumbent annual herbs with dense spicate inflorescences; schizocarps with 6 prominent wings formed from apical lobing of the dorsal and lateral ribs; mericarp wings ascending, flattened (and remaining so at maturity), margins with distinct undulate to finger-like lobing; mericarp surface between the dorsal and lateral ribs with 2 rows of pits separated by a raised undulate ridge (running parallel with the lateral ribs), similarly

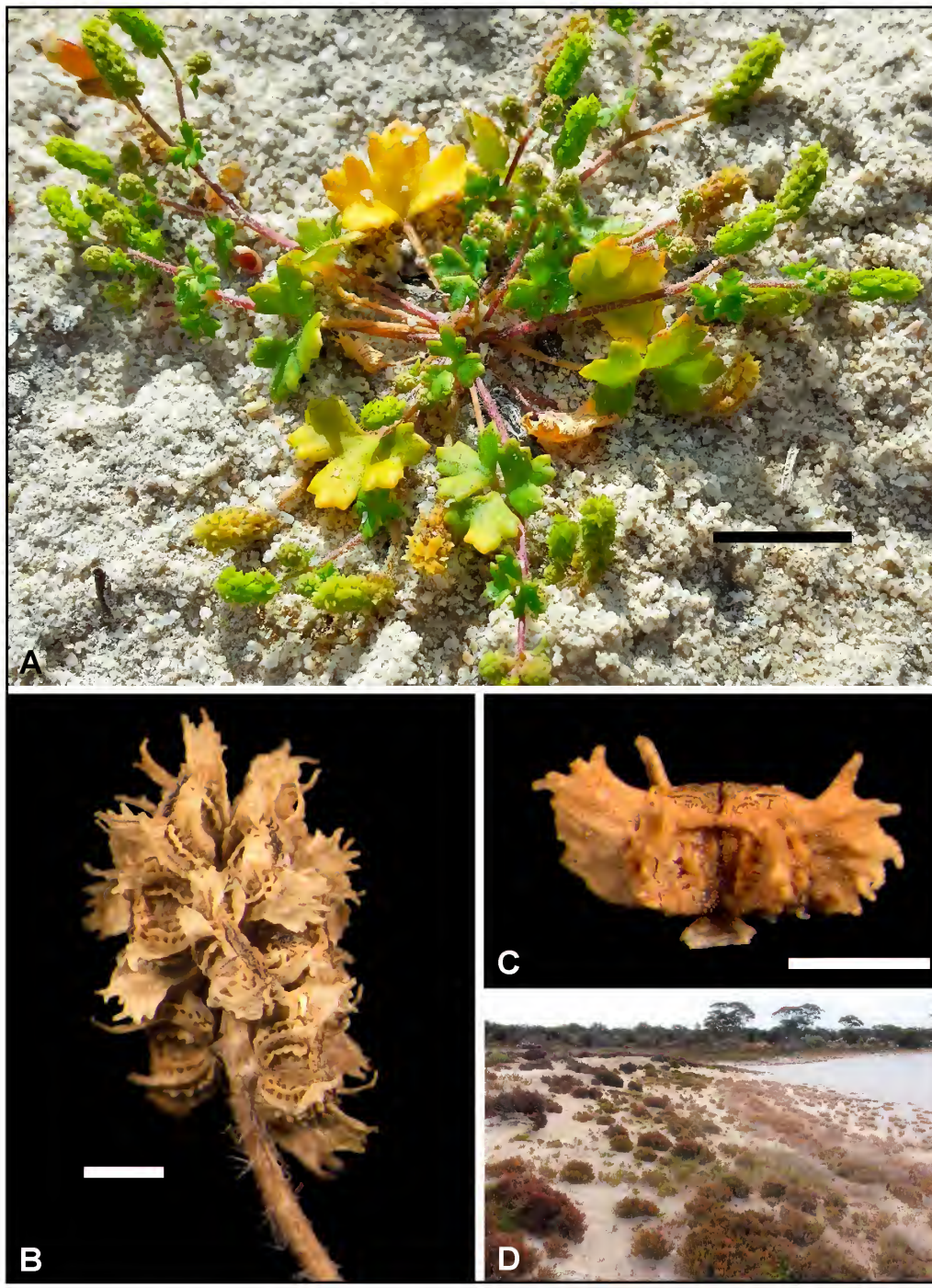

Figure 4. *Hydrocotyle decorata*. A – flowering plant *in situ* showing the habit and spicate inflorescences; B – infructescence with developing schizocarps bearing winged lobes; C – lateral view of a mature schizocarp showing winged lobes and pitted mericarp surface; D – typical habitat. Scale bars = 2 cm (A), 1 mm (B, C). Vouchers: *A.J. Perkins* AJP-WA 142 (A), *M. Graham* G 215-19 (B, C). Photographs by A. Perkins.

the mericarp surface between the lateral and median ribs with 2 rows of pits separated by a raised undulate ridge; carpophores acerose and persistent (Figure 4A–C).

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 31 Oct. 2005, *P. Armstrong* PA 05/772 (PERTH); 13 Sep. 1971, *Hj. Eichler* 21248 (CANB); 8 Sep. 1982, *Hj. Eichler* 22967 (CANB); 30 Sep. 1982, *Hj. Eichler* 23114 (CANB, PERTH); 30 Sep. 1982, *Hj. Eichler* 23115 (CANB); 5 Oct. 1982, *Hj. Eichler* 23149 (CANB); 19 Nov. 2007, *T. Erickson* TE 173 (K, PERTH); 3 Nov. 1965, *A.S. George* 7292 (CANB, PERTH); 27 Nov. 1994, *M. Graham* G 215-19 (PERTH); 17 Sep. 1998, *M.N. Lyons & S.D. Lyons* 4418 (PERTH); 27 Sep. 2005, *A.J. Perkins s.n.* (NSW, PERTH 08029628, SYD); 21 Oct. 2017, *A.J. Perkins* AJP-WA 142 (PERTH); 22 Oct. 2017, *A.J. Perkins* AJP-WA 143 (PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from September to November.

Distribution and habitat. *Hydrocotyle decorata* is known to occur near Lake King in the Mallee bioregion and Lake Cowan (near Norseman) in the Coolgardie bioregion (Western Australian Herbarium 1998–; AVH 2017) (Figure 2). Plants grow in sandy loam soils surrounding the margins of inland salt lakes, in low open shrubland, often in sheltered positions around mature plants of *Tecticornia* and *Frankenia* spp. (Figure 4D).

Conservation status. *Hydrocotyle decorata* is listed by Smith and Jones (2018) as Priority Two under Conservation Codes for Western Australian Flora, under the name *H.* sp. Hexaptera (T. Erickson TEE 173). The two areas of occurrence for this species are over 220 km apart (Figure 2).

Etymology. The epithet is derived from the Latin *decoratus*, 'decorative', in reference to the elaborate ornamentation of the fruit in this species (Figure 4B, C). The common name 'Decorative Pennywort' is here suggested.

Affinities. *Hydrocotyle decorata* differs from *H. asterocarpa* by having schizocarp wings that remain flattened at maturity (becoming inflated in *H. asterocarpa*), wings with undulate to finger-like lobing of the margins (mostly entire margins or occasionally shallowly lobed in *H. asterocarpa*) (Figures 1B, 4B). In contrast, the prominent lobing of the dorsal and lateral ribs in *H. medicaginoides* is spreading (not ascending) (Figure 3B, C) and only the dorsal ribs are narrowly winged in *H. perforata* (Figures 1B, C, 5B, C). Additionally, pitting on the mericarp surfaces in *H. decorata* are in two distinct rows separated by raised undulate ridges running in parallel with the lateral ribs (Figures 2B, 3B), whereas pitting on the mericarp surfaces in *H. asterocarpa* and *H. medicaginoides* are irregular in arrangement, being interspersed amongst the reticulate ridges (Figure 1C).

Hydrocotyle perforata A.J.Perkins, *sp. nov.*

Type: south of Balladonia Motel, Eyre Highway, Western Australia [precise locality withheld for conservation reasons], 16 September 1980, *K.R. Newbey* 7477 (*holo*: PERTH 03539873; *iso*: CANB 352120).

Hydrocotyle coraginaensis H.Eichler ms, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 13 October 2017].

Hydrocotyle sp. Coraginaensis (K.R. Newbey 7477), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 13 October 2017].

Annual herbs with a basal rosette of leaves and branched stems bearing leaves and spicate inflorescences, 2–7 cm high, 1–5 cm wide. *Stems* ascending, straight to sinuous, light green to crimson in colour, terete, villous. *Stipules* white, lanceolate to linear-lanceolate, 1.0–3.0 mm long, 0.5–1.5 mm wide, membranous, translucent, laciniate to fimbriate along margins. *Petioles* 4–15 mm long, light green, villous. *Leaf blades* simple, dorsiventral, carnose, rhombic to shallowly trilobed in juvenile leaves, shallow to deeply trilobed in mature leaves, 3–6 mm long, 3–12 mm wide; adaxial lamina surface light green, subglabrous to puberulous; abaxial lamina surface slightly lighter in colour than adaxial, subglabrous to puberulous. *Leaf margins* toothed; teeth rounded to obtuse or occasionally acute. *Median leaf lobes* ovate to oblanceolate, 3–6 mm long, 2–4 mm wide, with 1–3 marginal teeth. *Lateral leaf lobes* 2–6 mm long, 2–4 mm wide, with 1–4 marginal teeth; leaf sinuses 20–80% of lateral lobe length. *Inflorescences* leaf-opposed, spicate, 6–20-flowered. *Peduncles* terete, longer than subtending leaf when in fruit, 3–20 mm long, villous. *Involucral bracts* absent. *Rachis* 3–6 mm long, glabrous to sparsely villous. *Pedicels* light green, 0.2–0.5 mm long. *Flowers* all hermaphrodite, protandrous, densely arranged along the rachis. *Sepals* absent. *Petals* 5, cream with light crimson on the abaxial surface towards the apex, ovate, 0.5–0.8 mm long, 0.4–0.5 mm wide. *Filaments* light cream, 0.4–0.5 mm long. *Anthers* crimson or occasionally creamy yellow, elliptic, 0.2–0.3 mm long. *Ovaries* light green at anthesis, orbicular, dorsal and lateral ribs distinctly raised in profile. *Schizocarps* bilaterally flattened, symmetrical, broadly elliptic to broadly obovate, light green during early development turning reddish brown to dark brown at maturity, dorsal and lateral ribs prominently raised; commissure 90–95% the length of mericarps. *Mericarps* minutely verrucate to colliculate, 0.4–0.8 mm long, 0.6–0.8 mm wide; dorsal ribs conspicuous, bearing a slender wing at maturity; wing margins repand; lateral ribs prominently raised; mericarp surface between dorsal and lateral ribs with 2 longitudinal rows of pits bordered by raised undulate ridges; surface between lateral ribs and median ribs similarly with 2 (rarely 3) longitudinal rows of pits bordered by raised undulate ridges; ridges surrounding pits becoming thickened and more prominent leading up to fruit maturation. *Carpophores* persistent, acerose. *Fruiting styles* swollen at the base, 0.4–0.5 mm long, reflexed. *Cotyledons* oblong to oblanceolate in the seedlings. (Figure 5)

Diagnostic features. *Hydrocotyle perforata* can be distinguished from all other taxa in *Hydrocotyle* by possessing the following combination of characters: ascending annual herbs with dense spicate inflorescences; broadly elliptic to broadly obovate schizocarps with slender wings along the dorsal ribs; lateral ribs raised (but not lobed); mericarp surfaces distinctly pitted with 2 longitudinal rows of pits bordered by raised undulate ridges between the dorsal and lateral ribs, similarly with 2 rows of pits between lateral ribs and median ribs; carpophores acerose and persistent (Figure 5A–C).

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 29 Sep. 1990, *W.R. Archer* 2909903 (MEL); 7 Nov. 2007, *G. Cockerton & N. McQuoid* LCH 15782 (PERTH); 7 Sep. 1982, *Hj. Eichler* 22953 (CANB); 11 Sep. 1980, *K.R. Newbey* 7266 (PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from September to November.

Distribution and habitat. *Hydrocotyle perforata* is currently known from a locality near Salmon Gums in the Mallee bioregion and four localities south-west of Balladonia in the Coolgardie bioregion (Western Australian Herbarium 1998–; AVH 2017) (Figure 2). This species grows in sandy loam soils

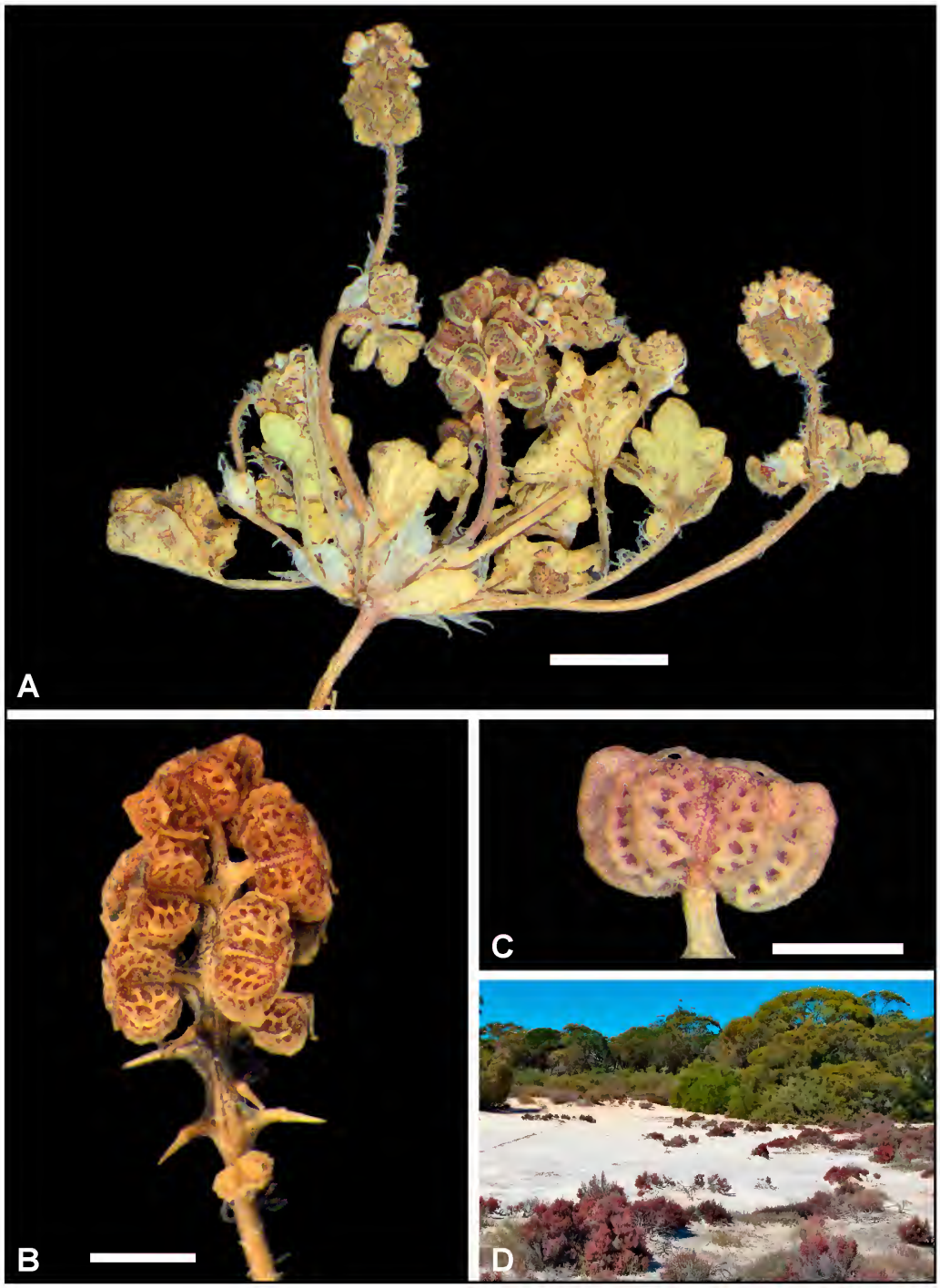

Figure 5. *Hydrocotyle perforata*. A – herbarium voucher showing a fertile plant with flowers and developing fruit borne on spicate inflorescences; B – infructescence showing mature schizocarps with pits in longitudinal rows; C – lateral view of a mature schizocarp showing slender wings along the dorsal ribs, raised lateral ribs and pitted mericarp surface; D – typical habitat in the Salmon Gums area. Scale bars = 5 mm (A), 1 mm (B, C). Vouchers: *K.R. Newbey* 7266 (A); *G. Cockerton & N. McQuoid* LCH 15782 (B, C). Photographs by A. Perkins.

surrounding the margins of inland salt lakes and in granitic sandy loams surrounding exposed granite outcropping or shallow granite sheeting of variable drainage.

Conservation status. *Hydrocotyle perforata* is listed by Smith and Jones (2018) as Priority Two under Conservation Codes for Western Australian Flora, under the name *H.* sp. Coraginaensis (K.R. Newbey 7477).

Etymology. The epithet is derived from the Latin *perforatus*, 'perforated', in reference to the perforated or pitted ornamentation of the fruit in this species (Figure 5A–C). The common name 'Pitted Pennywort' is here suggested.

Affinities. The schizocarps of *Hydrocotyle perforata* differ from *H. medicaginoides*, *H. asterocarpa* and *H. decorata* by having slender flattened wings along the dorsal ribs only (Figure 5B, C) and the lateral ribs being raised (lateral ribs with prominent lobing in *H. medicaginoides*, *H. asterocarpa* and *H. decorata*). Also, the undulate ridges that border the pits on the mericarp surfaces become thickened as the fruit reaches maturity, giving this species their distinctively pitted schizocarps (Figure 5A–C).

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The author thanks Julia Percy-Bower, Karina Knight and Skye Coffey (Western Australian Herbarium) for curatorial assistance, Barbara Rye and Robert Davis (Western Australian Herbarium) for constructive discussions regarding the taxonomic descriptions, and Mike Lyons (Department of Biodiversity, Conservation and Attractions) for providing additional vouchers from the Salinity Action Plan Flora Survey to the Western Australian Herbarium and for sharing his valuable field knowledge. Carolyn Connelly (National Herbarium of New South Wales) and Karen Muscat are thanked for assistance in the field. The curators of CANB (Australian National Herbarium) and MEL (National Herbarium of Victoria) are thanked for providing access to their holdings. Thanks also to Murray Henwood for access to additional CANB vouchers on loan to SYD (John Ray Herbarium) and the late Hansjörg Eichler for his contribution to the systematics of *Hydrocotyle*.

References

AVH (2017). *The Australasian Virtual Herbarium*, Council of Heads of Australasian Herbaria. https://avh.chah.org.au/ [accessed 13 October 2017].

Department of the Environment (2013). *Australia's bioregions (IBRA)*, IBRA7, Commonwealth of Australia. http://www.environment.gov.au/land/nrs/science/ibra#ibra [accessed 13 October 2017].

Duretto, M.F. (1999). Apiaceae. *In*: Walsh, N.G. & Entwisle, T.J. (eds) *Flora of Victoria*. Vol. 4. pp. 256–301. (Inkata Press: Melbourne.)

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora List 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 1 February 2018].

Western Australian Herbarium (1998–). *FloraBase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. https://florabase.dpaw.wa.gov.au/ [accessed 13 October 2017].

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SHORT COMMUNICATION

A key to *Ptilotus* (Amaranthaceae) in Western Australia

Ptilotus R.Br. (Amaranthaceae) is a genus of approximately 120 species, all of which are native to continental Australia and with most of the diversity occurring in Western Australia (Hammer *et al.* 2015). The key presented here for 96 Western Australian taxa is a continuation of on-going work to produce an Australia-wide key for *Ptilotus* by the authors, which was originally presented on *KeyBase* (available at http://keybase.rbg.vic.gov.au/keys/show/6609, accessed 16 August 2018; previously mentioned in Hammer & Davis 2018). The Western Australian key was constructed by examining specimens lodged at the Western Australian Herbarium (PERTH) and includes all of the 93 named species now recognised (i.e. excluding *P. petiolatus* Farmar and including *P. unguiculatus* T.Hammer; see Hammer 2018). The subspecies of *P. polakii* F.Muell., *P. sericostachyus* (Nees) F.Muell. and *P. stirlingii* (Lindl.) F.Muell. are also included in the key. However, the infraspecific taxa of *P. drummondii* (Moq.) F.Muell., *P. obovatus* (Gaudich.) F.Muell. and *P. schwartzii* (F.Muell.) Tate, currently recognised on the plant census for Western Australia, were excluded pending on-going studies into their taxonomic status. Also excluded from the key are the phrase names *P.* sp. Beaufort River (G.J. Keighery 16554), *P.* sp. Mt Narryer (A.S. George 17484) and *P.* sp. Porongorup (R. Davis 10805), which are in need of further study.

As new species are discovered (e.g. Davis & Hammer 2018; Hammer & Davis 2018) and new evidence is found to change existing taxonomic concepts (e.g. Hammer *et al.* 2018a, 2018b), there will no doubt be future revisions needed to this Western Australian key. An interactive version of it is available on *KeyBase* (http://keybase.rbg.vic.gov.au/keys/show/6627, accessed 8 August 2018) as part of the *Flowering plants of Western Australia* project.

Notes on distinctive characters

We use 'sepal' in this key instead of the traditionally used 'tepal' to describe the uniseriate perianth of *Ptilotus* (for more information, see Hammer 2018). All species of *Ptilotus* have five sepals, with two outer enclosing three inner in bud. Inner and outer sepals may differ conspicuously in morphology, or may be almost indistinguishable in fully open flowers. The term 'clawed' refers to the base of the sepal being conspicuously narrower than the dilated apex. Enclosing the base of the solitary flower are two opposite bracteoles (i.e. the prophylls), which in *Ptilotus* are membranous and can be translucent or opaque and hairy or glabrous. At the base of the bracteoles is a single bract, which is alternate to the two bracteoles (for more information on this flowering arrangement, see Acosta *et al.* 2009). The morphology of the bract and the bracteoles is often diagnostic.

Early steps in the key include the placement of the style on the ovary summit, and the number of fertile stamens. The style is usually either clearly central or clearly excentric (see Figure 4 in Hammer *et al.* 2015); where this is ambiguous or where we have found infraspecific variation, we have included the species in both sections of the key. The androecium of *Ptilotus* is 5-merous, usually comprising a distinct androecial cup with stamens or staminodes opposite the sepals (Figure 1A, B). Commonly, one or more stamens are infertile and reduced to staminodes. The number of fertile stamens is consistent within species and across geographic ranges (e.g. Hammer *et al.* 2018b), with the exception of *P. manglesii*

https://florabase.dpaw.wa.gov.au/nuytsia/ ISSN 2200-2790 (Online) ISSN 0085-4417 (Print)

Figure 1. Morphology of the androecium in *Ptilotus*. A – five fertile stamens opposite sepals in *P. luteolus* (Benl & H.Eichler) R.W.Davis; B – five fertile stamens opposite sepals in *P. grandiflorus* F.Muell.; C – reduced stamen number to two with three showy staminodes in *P. appendiculatus* Benl; D – reduced stamen number to four with an inconspicuous staminode in *P. gaudichaudii* (Steud.) J.M.Black. Horizontal arrows indicate staminodes (C, D) and vertical arrows indicate fertile stamens (C). Photographs by R. Davis (A) and T. Hammer (B–D).

(Lindl.) F.Muell., which may have three to five fertile stamens in different flowers on an individual plant. Infertile stamens (staminodes) may be showy (sometimes flattened and coloured; Figure 1C) or may comprise a reduced filament that appears as an inconspicuous appendage on the staminal cup (Figure 1D). In some species a staminode may be so reduced that it appears as just a minute projection on the staminal cup or, rarely, may appear completely absent. In addition, some species have small appendages (previously called 'pseudostaminodes') that project from the staminal cup and alternate with the stamens or staminodes.

Many species of *Ptilotus* are gynodioecious, i.e. populations comprise a mix of male-sterile (i.e. functionally female) and bisexual plants (Stewart & Barlow 1972; Hammer *et al.* 2018a; Figure 2). Bisexual plants have a fully developed androecium comprising one to five fertile stamens and up to four staminodes as described above. In male-sterile plants, all of the fertile stamens fail to fully form, leaving reduced appendages with clearly non-functional anthers (Figure 2B). While gynodioecy is common in the genus, it has not been adequately surveyed between and within species. In some species

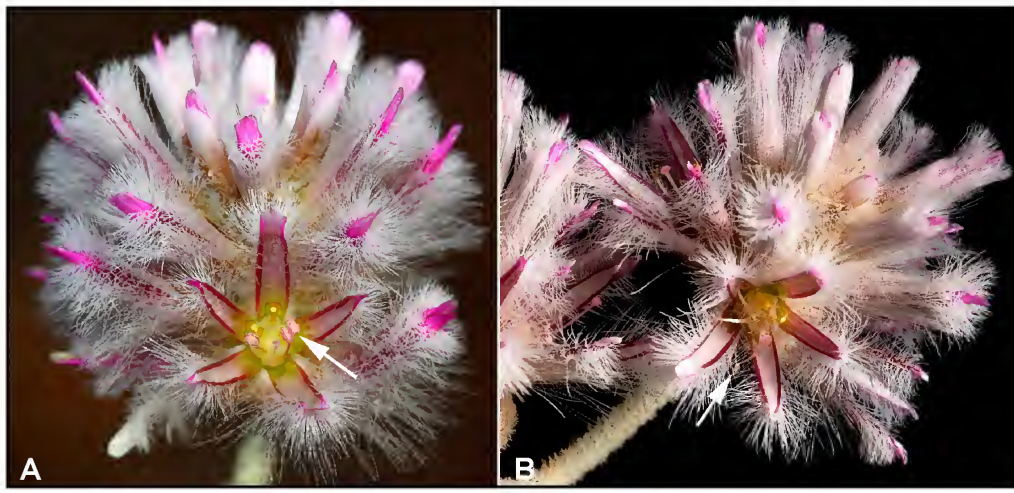

Figure 2. Variation of stamens in the gynodioecious *P. obovatus*, showing flowers of a bisexual individual on the left and a female individual on the right. Arrows indicate fertile (A) and poorly-developed (B) anthers. Photographs by R. Davis (A) and K. Thiele (B).

(e.g. *P. obovatus* and *P. schwartzii*) the ratio of male-sterile to bisexual plants may be very high; in others, occasional male-sterile individuals may be found in populations that are mostly bisexual (e.g. *P. exaltatus* Nees; Hammer *et al.* 2018a). Male-sterile individuals can be identified using this key, but care should be taken in couplet 3 to discriminate stamens (with poorly developed anthers) from staminodes (which lack anthers). Stamens with anthers in such individuals are counted as fertile in this couplet, despite being functionally sterile. One species (*P. crispus* Benl) is truly dioecious, with all individuals either female and lacking an androecium, or male with the ovary reduced and lacking a style.

Indumentum in all species comprises multi-cellular hairs, ranging from simple to branching, i.e. verticillate or dendritic (see Hammer *et al.* 2015, 2017 for discussions and figures). Simple hairs are described as nodose when the nodes between hairs are swollen and septate when they are not. Verticillate hairs have distinct whorls of side-branches at the nodes; in dendritic hairs, the side-branches do not form distinct whorls.

Key to *Ptilotus* in Western Australia

Taxa marked with an asterisk appear more than once in the key.

1. Sepals < 1.6 mm long; flowers unisexual, the males lacking styles, the females lacking sterile stamens ..... **P. crispus**

1: Sepals 2–50 mm long; flowers bisexual, or functionally female with sterile stamens

2. Style excentrically placed on the ovary summit

3. Fertile stamens 1 or 2

4. Ovary glabrous

5. Stems herbaceous

6. Fertile stamen 1 ..... **P. alexandri**

6: Fertile stamens 2

7. Adaxial surface of inner sepals with a basal tuft of hairs

8. Leaves thick, semi-succulent to succulent; flowers green; sepals with short, appressed hairs on abaxial surface ..... **P. chortophytus**

8: Leaves flat, not semi-succulent or succulent; flowers pink to purple; sepals with long, spreading hairs on abaxial surface

9. Plants decumbent; bracts 1.8–4.5 mm long; bracteoles 3–5 mm long ..... **P. stirlingii** subsp. **stirlingii**

9: Plants prostrate; bracts 5.3–6 mm long; bracteoles 5.4–6.3 mm long ..... **P. stirlingii** subsp. **australis**

7: Adaxial surface of inner sepals ± glabrous

10. Staminodes conspicuous, *c.* 2 mm long ..... **P. halophilus**

10: Staminodes minute or absent

11. Bracts 6.5–7 mm long ..... **P. sericostachyus** subsp. **roseus**

11: Bracts 4–5.7 mm long ..... **P. sericostachyus** subsp. **sericostachyus**

5: Stems woody or basally woody

12. Leaves petiolate

13. Glabrous portion of outer sepal apex 3–5 mm long; bracts ± equal in length to bracteoles; style 6–10 mm long ..... **P. polakii** subsp. **polakii**

13: Glabrous portion of outer sepal apex 1–2 mm long; bracts shorter than bracteoles; style 4–5.5 mm long ..... **P. polakii** subsp. **juxtus**

12. Leaves sessile or subsessile

14. Stems erect or ascending; leaves not crowded at the base of the stem ..... **P. beardii**

14: Stems prostrate, mat-forming; leaves crowded at the base of the stem

15. Sepals < 7 mm long, apex not rounded (presumed extinct) ..... **P. caespitulosus**

15: Sepals > 8 mm long, apex rounded ..... **P. fasciculatus**

4: Ovary hairy

16. Stems herbaceous

17. Inner sepals with a prominent basal tuft of hairs inside

18. Leaves with persistent verticillate hairs on adaxial surface to 2 mm long ..... **P. andersonii**

18: Leaves glabrous or glabrescent

19. Flowers pink; sepal apex rounded and dilated; lower portion of sepals densely hairy ..... **P. chippendalei**

19: Flowers creamish green; sepal apex acute, not dilated; lower portion of sepals glabrous ..... **P. seminudus**

17: Inner sepals without basal tuft of hairs inside

20. Bracts longer than bracteoles ..... **P. blackii**

20: Bracts shorter than bracteoles

21. Leaves with persistent villous indumentum ..... **P. appendiculatus**

21: Leaves mostly glabrous ..... **P. axillaris**

16: Stems woody or basally woody

22. Bracts shorter than bracteoles

23. Stems divaricately branching ..... **P. lazaridis**

23: Stems with no pattern of branching, i.e. not divaricate

24. Leaves > 3 mm wide, not in fascicles

25. Leaves with persistent verticillate hairs ..... **P. kenneallyanus***

25: Leaves glabrous ..... **P. stipitatus**

24: Leaves < 1.6 mm wide, in fascicles

26. Stems hairy; sepals 15–19 mm long ..... **P. daphne**

26: Stems glabrous; sepals 11–13 mm long ..... **P. rigidus**

22: Bracts longer than bracteoles

27. Leaves glabrous or glabrescent, incurved, semi-succulent ..... **P. yapukaratja**

27: Leaves with persistent verticillate hairs, not as above ..... **P. kenneallyanus***

3: Fertile stamens 3–5

28. Ovary glabrous

29. Stems prostrate or decumbent

30. Annuals

31. Outer sepals at least 10 mm longer than inner sepals ..... **P. crosslandii**

31: Outer and inner sepals similar in size

32. Sepals glabrous, apex truncate-serrate ..... **P. grandiflorus***

32: Sepals with straight hairs on abaxial surface, apex acute ..... **P. procumbens**

30: Perennials

33. One stamen modified into a conspicuous staminode to 17 mm long ..... **P. declinatus**

33: Stamens all fertile or staminodes short and inconspicuous

34. Sepals with hairs exceeding the apex ..... **P. symonii**

34: Sepals with hairs not exceeding the apex

35. Inflorescences becoming long-cylindrical; basal leaves distinctly spathulate ..... **P. spathulatus**

35: Inflorescences mostly ovoid; basal leaves oblanceolate

36. Plants single-stemmed ..... **P. clivicola**

36: Plants multi-stemmed

37. Sepals white to green; bracts prominently sickle-shaped ..... **P. falcatus**

37: Sepals pink; bracts not sickle-shaped ..... **P. manglesii***

29: Stems erect

38. Leaves with hairs obscuring surface

39. Staminodes absent or obscure ..... **P. eriotrichus**

39: Staminodes prominent and coloured

40. Staminodes pink; sepals 12–20 mm long ..... **P. sessilifolius**

40: Staminodes yellow; sepals 6.5–9.5 mm long..... **P. incanus**

38: Leaves glabrous or with sparse hairs not obscuring the surface

41. Stems woody or basally woody, divaricately branching ..... **P. divaricatus**

41: Stems herbaceous, not divaricately branching

42. Small herb < 8 cm tall; basal rosette of spathulate leaves ..... **P. pyramidatus**

42: Herbs > 8 cm tall; leaves not as above

43. Sepals with hairs restricted to midrib of abaxial surface ..... **P. gaudichaudii***

43: Sepals with hairs not restricted to midrib of abaxial surface

44. Bracts opaque; fertile stamens 3

45. Flowers purple to pink; sepals gaping widely at anthesis, straight; ovary obscured by a plug of woolly hairs at the base of the sepals ..... **P. exaltatus***

45: Flowers creamish green, rarely with a pale pink flush; sepals not gaping widely at anthesis, ± falcately down-curved; ovary not obscured, the hairs at the base of the sepals ± erect, not forming a woolly plug..... **P. nobilis***

44: Bracts translucent; fertile stamens 4 or 5

46. Sepal abaxial surface glabrous apart from basal hairs; flowers pink; fertile stamens 5 ..... **P. grandiflorus***

46: Sepal abaxial surface hairy apart from apex; flowers cream to green; fertile stamens 4

47. Inflorescences 30–60 mm wide; flowers not opening broadly, radially symmetric; old flowers not appressed to rachis..... **P. macrocephalus***

47: Inflorescences 18–28 mm wide; flowers opening broadly, bilaterally symmetric; old flowers appressed to rachis..... **P. polystachyus***

28: Ovary hairy

48. Perennials

49. Inflorescences interrupted..... **P. distans**

49: Inflorescences not interrupted

50. Stems prostrate or decumbent

51. Bracts dark, opaque; sepal apex glabrous for 4–8 mm, truncate-serrate..... **P. manglesii***

51: Bracts translucent; sepal apex hairy, acute ..... **P. holosericeus**

50: Stems erect

52. Stems woody or basally woody (when young); sepals without densely woolly indumentum on the adaxial surface; staminodes 2, flattened, yellow and showy ..... **P. obovatus**

52: Stems herbaceous; sepals with densely woolly indumentum on the adaxial surface; staminodes 2, filiform, not showy, obscured by woolly sepal hairs..... **P. exaltatus***

48: Annuals

53. Inner sepals adaxially glabrous

54. Outer sepals much longer than inner ..... **P. trichocephalus**

54: Outer and inner sepals subequal

55. Sepals with hairs restricted to midrib on abaxial surface

56. Sepals 10–15 mm long; anthers > 0.9 mm long ..... **P. gaudichaudii***

56: Sepals 6–9 mm long; anthers < 0.6 mm long ..... **P. eremita**

55: Sepals with hairs not restricted to midrib on abaxial surface

57. Sepal apex truncate-serrate; flowers orange to yellow ..... **P. carlsonii**

57: Sepal apex acute; flowers creamish green, sometimes with pale pinkish tinge

58. Stems prostrate, sprawling; sepals < 6 mm long ..... **P. aervoides***

58: Stems erect or ascending; sepals > 8 mm long

59. Ovary with a distinct coma of hairs ..... **P. fusiformis**

59: Ovary without a distinct coma of hairs

60. Inflorescences 30–60 mm wide; flowers not opening broadly, radially symmetric; old flowers not appressed to rachis ..... **P. macrocephalus***

60: Inflorescences 18–28 mm wide; flowers opening broadly, bilaterally symmetric; old flowers appressed to rachis

61. Pedicel (i.e. the stalk attaching the bract and flowering unit to the rachis) after abscission squat, with a prominent disc at apex; ovary gibbous; staminal cup with sparse, short hairs ..... **P. polystachyus***

61: Pedicel (i.e. the stalk attaching the bract and flowering unit to the rachis) after abscission slender, with a reduced disc at apex; ovary not gibbous; staminal cup with copious, long, silky hairs ..... **P. giganteus**

53: Inner sepals adaxially hairy or with row of hairs on inwardly folding margins

62. Inflorescences interrupted ..... **P. tetrandrus**

62: Inflorescences not interrupted

63. Bracts glabrous, translucent

64. Flowers green; sepals > 15 mm long; staminode inconspicuous ..... **P. macrocephalus***

64: Flowers pink; sepals < 10 mm long; staminode conspicuous

65. Sepals > 6 mm long; staminode > 3 mm long; anthers > 0.6 mm long ..... **P. helipteroides***

65: Sepals < 5.5 mm long; staminode < 2.6 mm long; anthers < 0.6 mm long ..... **P. actinocladus**

63: Bracts hairy, opaque

66. Sepals < 10 mm long ..... **P. carinatus**

66: Sepals > 16 mm long

67. Flowers purple to pink; sepals gaping widely at anthesis, straight; ovary obscured by a plug of woolly hairs at the base of the sepals ..... **P. exaltatus***

67: Flowers creamish green, rarely with pale pink flush; sepals not gaping widely at anthesis, ± falcately down-curved; ovary not obscured, the hairs at the base of the sepals ± erect, not forming a woolly plug..... **P. nobilis***

2: Style centrally placed on the ovary summit

68. Leaves persistently hairy

69. Stems herbaceous

70. Bracts and bracteoles longer than sepals..... **P. decipiens***

70: Bracts and bracteoles shorter than sepals

71. Inflorescences nodding; flowers creamish green

72. Bracteoles glabrous; leaves to 45 mm long with velvety indumentum..... **P. gardneri**

72: Bracteoles pilose; leaves to 90 mm long with villous indumentum..... **P. clementii**

71: Inflorescences not nodding; flowers pink..... **P. helipteroides***

69: Stems woody or basally woody

73. Ovary glabrous

74. Abaxial sepal hairs woolly, clearly exceeding apex..... **P. albidus**

74: Abaxial sepal hairs not woolly, not exceeding apex

75. Leaves > 30 mm wide

76. Sepals and staminal filaments pink; inflorescences > 30 mm wide..... **P. rotundifolius**

76: Sepals creamish green; staminal filaments white; inflorescences < 21 mm wide..... **P. marduguru**

75: Leaves < 20 mm wide

77. Leaves narrowly oblanceolate to narrowly elliptical..... **P. wilsonii**

77: Leaves ovate to spathulate

78. Stems and leaves with yellow, villous indumentum of long, branching hairs..... **P. luteolus**

78: Stems and leaves with grey-green, tomentose indumentum of short, branching hairs..... **P. astrolasius**

73: Ovary hairy

79. Stamens longer than sepals..... **P. helichrysoides**

79: Stamens shorter than sepals

80. Flowers interrupted, in solitary, terminal spikes..... **P. royceanus**

80: Flowers densely arranged, in terminal panicles..... **P. mollis**

68: Leaves glabrous or glabrescent, or mature plants leafless

81. Stems erect

82. Staminal cup appendages present

83. Bracteoles longer than sepals..... **P. latifolius**

83: Bracteoles shorter than sepals

84. Sepals green; inflorescences > 24 mm wide..... **P. benlii**

84: Sepals pink to pale pink or whitish; inflorescences < 20 mm wide

85. Stems leafless at maturity ..... **P. aphyllus**

85: Stems with leaves at maturity

86. Erect, slender herbs; taproot fleshy; inflorescences cylindrical ..... **P. calostachyus**

86: Rounded herbs or subshrubs (stems basally woody); taproot woody; inflorescences globular to ovoid

87. Stems becoming woody, branching; leaves narrow-linear, sparse ..... **P. schwartzii**

87: Stems herbaceous, simple; leaves lanceolate to spathulate, basally crowded..... **P. drummondii***

82: Staminal cup appendages absent

88. Inner sepals glabrous on adaxial surface

89. Stems herbaceous

90. Sepal abaxial surface glabrescent, hairs concentrated at apex..... **P. decalvatus**

90: Sepal abaxial surface with persistent hairs at base or throughout

91. Sepals woolly at base of abaxial surface, glabrous at apex..... **P. gomphrenoides***

91: Sepals villous throughout length of abaxial surface..... **P. lanatus**

89: Stems woody

92. Style ± straight..... **P. arthrolasius**

92: Style conspicuously sigmoid ..... **P. chrysocomus**

88: Inner sepals with hairs on adaxial surface or on inner margins

93. Inner sepals clawed

94. Inflorescence units in corymb- or umbel-like clusters.....

95. Inflorescence units hemispherical to ovoid, in loose corymbs..... **P. corymbosus**

95: Inflorescence units obovoid, in dense umbel-like clusters..... **P. johnstonianus**

94: Flowers not clustered as above

96. Staminal filaments narrowly ligulate, dilated into a disc under anthers..... **P. conicus**

96: Staminal filaments not as above

97. Bracts and bracteoles with an awn-like apex

98. Staminal cup with divergent, forked appendages..... **P. capitatus**

98: Staminal cup without appendages..... **P. spicatus**

97: Bracts and bracteoles without awn-like apex ..... **P. mitchellii***

93: Inner sepals not clawed

99. Abaxial sepal hairs exceeding sepal apex

100. Bracteoles as long as sepals ..... **P. villosiflorus**

100: Bracteoles at most half the length of sepals..... **P. subspinescens**

99: Abaxial sepal hairs not exceeding sepal apex

101. Inflorescences nodding; staminal cup long and tube-like, 8–11 mm long.... **P. auriculifolius**

101: Inflorescences not nodding; staminal cup short, < 1.5 mm long

102. Bract apex aristate ..... **P. decipiens***

102: Bract apex not aristate ..... **P. mitchellii***

81: Stems prostrate or decumbent

103. Inner sepals hairy adaxially

104. Sepal apex acute

105. Plants mat-forming; stems prostrate, persistently stellate-hairy ..... **P. roei**

105: Plants not mat-forming; stems decumbent or erect, glabrous or glabrescent

106. Staminal cup appendages present ..... **P. drummondii***

106: Staminal cup appendages absent

107. Sepals conspicuously clawed ..... **P. unguiculatus***

107: Sepals not clawed ..... **P. esquamatus**

104: Sepal apex truncate-serrate

108. Sepals 3.5–4.5 mm long, sparsely silky-hairy abaxially ..... **P. exiliflorus**

108: Sepals 5–7.7 mm long, densely woolly abaxially ..... **P. humilis**

103: Inner sepals glabrous adaxially

109. Ovary villous-woolly at summit ..... **P. aervoides***

109: Ovary glabrous

110. Sepals not clawed

111. Inflorescences ± pedunculate; outer sepals with a rounded apex; inner sepal midrib region 0.5–0.8 mm wide ..... **P. gomphrenoides***

111: Inflorescences sessile; outer sepals acute; inner sepal midrib region 0.2–0.3 mm wide ..... **P. murrayi**

110: Sepals conspicuously clawed

112. Staminal cup appendages present ..... **P. chamaecladus**

112: Staminal cup appendages absent ..... **P. unguiculatus***

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References

Acosta, J.M., Perreta, M., Amsler, A. & Vegetti, A.C. (2009). The flowering unit in the synflorescences of Amaranthaceae. *The Botanical Review* 75: 365–376.

Davis, R.W. & Hammer, T.A. (2018). *Ptilotus yapukaratja* (Amaranthaceae), a new species from the Gascoyne bioregion of Western Australia. *Nuytsia* 29: 157–160.

Hammer, T.A. (2018). The *Ptilotus murrayi* species group: synonymisation of *P. petiolatus* under *P. murrayi* and description of the new Western Australian species *P. unguiculatus* (Amaranthaceae). *Swainsona* 31: 93–100.

Hammer, T.A. & Davis, R.W. (2018). *Ptilotus actinocladus* (Amaranthaceae), a new and rare species from the Gascoyne bioregion, Western Australia. *Nuytsia* 29: 145–149.

Hammer, T., Davis, R. & Thiele, K. (2015). A molecular framework phylogeny for *Ptilotus* (Amaranthaceae): Evidence for the rapid diversification of an arid Australian genus. *Taxon* 64(2): 272–285.

Hammer, T.A., Davis, R.W. & Thiele, K.R. (2017). *Wadithamnus*, a new monotypic genus in Amaranthaceae. *Phytotaxa* 295(2): 173–184.

Hammer, T.A., Davis, R.W. & Thiele, K.R. (2018a). The noble and the exalted: a multidisciplinary approach to resolving a taxonomic controversy within *Ptilotus* (Amaranthaceae). *Australian Systematic Botany* 31(3): 262–280.

Hammer, T.A., Davis, R.W. & Thiele, K.R. (2018b). The showy and the shy: reinstatement of two species from *Ptilotus gaudichaudii* (Amaranthaceae). *Australian Systematic Botany* 31(1): 1–7.

Stewart, D.A. & Barlow, B.A. (1976). Infraspecific polyploidy and gynodioecism in *Ptilotus obovatus* (Amaranthaceae). *Australian Journal of Botany* 24: 237–248.

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SHORT COMMUNICATION

Cyanthillium gracilis, a new combination for the Western Australian endemic *Pleurocarpaea gracilis* (Asteraceae: Vernonieae)

Pleurocarpaea gracilis Lander & P.J.H.Hurter was described to provide a name for a rare species of daisy endemic in the Pilbara region of Western Australia, where it is known only from the summits of mountain peaks on banded ironstones of the Brockman Formation (Lander & Hurter 2013).

At the time of its description, the species was regarded as belonging in tribe Vernonieae Cass. subtribe Linziinae S.C.Keeley & H.Rob, based on its morphology and following the classification of Keeley and Robinson (2009). The mainly tropical tribe Vernonieae is not well-represented in the Australian native flora, with Lander & Hurter (2013) regarding that only one genus, *Pleurocarpaea* Benth., was native (several other genera are introduced). The new species was placed somewhat tentatively in *Pleurocarpaea*, the authors noting that mature achenes were unavailable at the time of publication, and that it 'fits broadly' within that genus 'pending the availability of specimens with fully mature achenes and further research on Australian Vernonieae' (*l.c.* p. 109).

A recent taxonomic treatment of tribe Vernonieae for *Flora of Australia* (Ghafoor 2015) lists ten genera comprising 17 species and infraspecies taxa in Australia. Of the latter, 11 are regarded as introduced and six, *viz Centratherum riparium* (DC.) A.R.Bean, *Pleurocarpaea denticulata* Benth., *P. fasciculata* Dunlop, *P. gracilis*, *Cyanthillium cinereum* (L.) H.Rob. var. *pinnatifidum* Ghafoor and *Vernonia junghuhniana* J.Kost., as native. Only *Pleurocarpaea* is endemic in Australia, the other genera with native species being generally widely distributed in the tropics.

In 2015 one of us (ES) sequenced a recently-collected specimen (*H. Hughes & S. Hitchcock* Opp 3-2; PERTH 07984731) of *P. gracilis* for the internal transcribed spacer (ITS), and conducted a BLAST search against GenBank. The *P. gracilis* sequence most closely matched multiple sequences of *Cyanthillium cinereum* at 97% similarity. Outside *Cyanthillium* Blume the next best match was 93%. Genbank ITS sequences of *Pleurocarpaea denticulata* did not make the top 100 BLAST hits.

This result strongly suggested that *P. gracilis* is incorrectly placed in *Pleurocarpaea*, and should be regarded as a species of *Cyanthillium*. Subsequent phylogenetic analyses based on ITS sequence data confirm this with high support. For this reason, it is here formally transferred to *Cyanthillium*, as *C. gracilis* (Lander & P.J.H.Hurter) K.R.Thiele & E.E.Schill.

Methods

DNA was extracted, amplified, and sequenced following the protocols in Schilling (2011). Briefly, DNA was extracted from leaf material using a DNeasy plant minikit (Qiagen, Valencia, California); ITS amplifications used the ITS-4 and ITS-5 primers (White *et al.* 1990); and sequencing was performed with the ABI Prism BigDye Terminator cycle sequencing ready reaction kit, v. 3.1 (Perkin-Elmer/Applied Biosystems, Foster City, California) and electrophoresed and detected on an ABI Prism 3100 automated sequencer (University of Tennessee Molecular Biology Resource Facility, Knoxville, Tennessee).

https://florabase.dpaw.wa.gov.au/nuytsia/
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Sequences for the ITS region from other members of Vernonieae were downloaded from GenBank, and aligned using MAFFT (Katoh & Standley 2013). Phylogenetic analyses to assess placement of *P. gracilis* were run using Maximum Likelihood implemented with RAxML v. 7.2.8 (Stamatakis 2014). Sequences from *Helichrysum hamulosum* DC. (Gnaphalieae Lecoq & Juillet) and *Cotula bipinnata* Thunb. (Anthemideae Cass.) were used as the outgroup.

Results

In the RAxML ITS tree (Figure 1), *P. gracilis* is weakly supported (BS=62%) as sister to the Sri Lankan *Cyanthillium hookerianum* (Arn.) H.Rob., with *P. gracilis*+*C. hookerianum* sister to *C. cinereum* and *C. montanum* (C.B.Clarke) Bunwong, Chantar. & S.C.Keeley with moderate support (BS=80%). These species together comprise a monophyletic *Cyanthillium*. This clade in turn is part of a well-supported clade comprising species of *Hilliardiella* H.Rob., *Polydora* Fenzl, *Parapolydora* H.Rob and *Vernonia* Schreb. (further species of the latter genus are widely scattered in the tree, indicating that it may not be monophyletic). *Pleurocarpaea denticulata* is distant, placed with poor support in a clade with species of *Linzia* Sch.Bip. ex Walp.

Discussion

While the analysis above should not be regarded as a definitive outline of generic relationships in tribe Vernonieae, it strongly indicates that *P. gracilis* is only distantly related to *P. denticulata* and should be transferred to *Cyanthillium*.

Comparison with specimens held at PERTH and with species and genus descriptions in Ghafoor (2015) indicates that *P. gracilis* is also morphologically better placed in *Cyanthillium* than in *Pleurocarpaea*. It shares with the former epaleate receptacles (paleate in *Pleurocarpaea*) and achenes with a prominent pappus of numerous capillary bristles 4–5 mm long (pappus absent or of few, stout bristles <1 mm long in *Pleurocarpaea*).

Accordingly, *P. gracilis* is recombined below into *Cyanthillium* as *C. gracilis*.

Key to species of *Cyanthillium* in Australia

The following key is amended from that provided in Ghafoor (2015).

1. Perennial, suffruticose herb to 40 cm high; leaves < 10 mm long, ≤ 5 mm wide ..... **C. gracilis**

1: Annual, erect herbs to 1.25 m; leaves 10–100 mm long, to 50 mm wide

2. Involucre cylindrico-campanulate, 2.5–3.5 mm wide; florets 15–20 per capitulum; achenes ±ribless, densely setulose; pappus biseriate, inner longer bristles about as long as corolla, outer shorter bristles persistent ..... **C. cinereum**

2: Involucre hemispherical to depressed-subglobose, 5–10 mm wide; florets 75–90 per capitulum; achenes 4- or 5-ribbed, glabrous and glandular; pappus uniseriate, delicate, with bristles much shorter than corolla ..... **C. patulum**

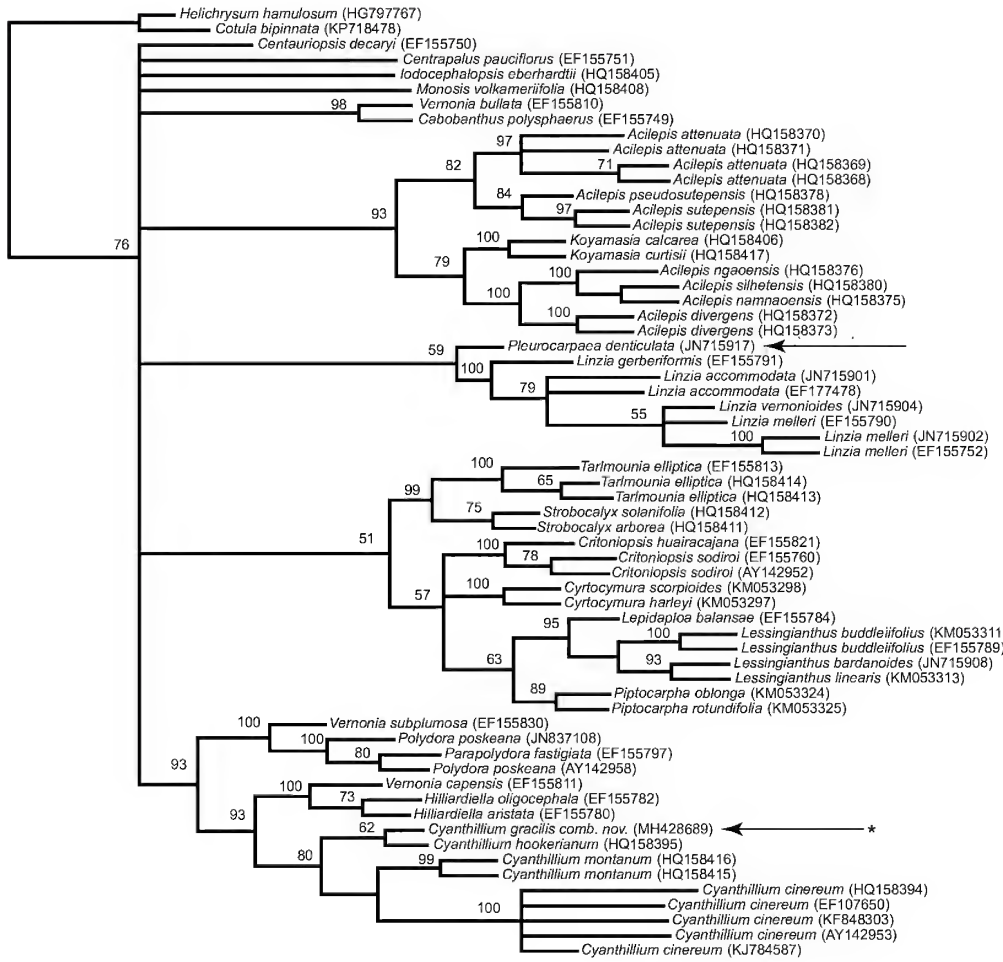

Figure 1. Tree showing relationships of *Cyanthillium gracilis comb. nov.* (arrowed, asterisked) and its clear separation from *Pleurocarpaea*, represented by *P. denticulata* (arrowed), within tribe Vernonieae based on RAxML analysis of DNA sequence data from the nuclear ribosomal internal transcribed spacer (ITS) region. Bootstrap values shown above branches. Genbank reference numbers in parentheses following species names.

Taxonomy

Cyanthillium gracilis (Lander & P.J.H.Hurter) K.R.Thiele & E.E.Schill., *comb. nov.*

Basionym: *Pleurocarpaea gracilis* Lander & P.J.H.Hurter, *Nuytsia* 23: 110–114.

Specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 3 June 2012, *H. Hughes & S. Hitchcock* Opp 3-2 (PERTH); 5 June 2012, *S. Kern* Opp 59 (PERTH); 9 May 2012, *S. Kern & M. Mikli* Opp 07 (PERTH); 9 May 2012, *S. Kern & M. Mikli* WH 12125-05 (PERTH); 14 May 2012, *S. Kern & M. Mikli* Opp 22 (PERTH); 16 May 2012, *S. Kern & M. Mikli* Opp 31 (PERTH); 4 June 2012, *S. Kern & M. Mikli* Opp 28 (PERTH); 15 Oct. 1998, *S. van Leeuwen* 4387 (PERTH); 14 Oct. 1998, *S. van Leeuwen* 4345 (PERTH); 7 July 2011, *E. Thoma* 1596 (PERTH); 18 Apr. 2013, *B. Watkins & E. Thoma* ET 1633 (PERTH).

Conservation status. *Cyanthillium gracilis* is listed by Smith and Jones (2018), under *P. gracilis*, as Priority Three under the Conservation Codes for Western Australian Flora.

Notes. In the protologue description, *P. gracilis* is described as a perennial suffruticose herb. Under the heading *Distinguishing features*, however, it is described as annual, like *P. fasciculata*. Specimen notes usually describe it as a 'rounded subshrub' with no indication of longevity. It is likely that *C. gracilis* is a short-lived perennial. The other species of *Cyanthillium* occurring in Australia (*C. cinereum*, *C. patulum*) are erect annuals; however, some non-Australian species are perennial and ±shrubby (Ghafoor 2015).

Acknowledgements

We thank Josh Mylne (University of Western Australia) for logistical help with the sequencing for this project, and for supporting travel by ES to Australia.

References

Ghafoor, A. (2015). Vernonieae. *In*: Wilson, A. (ed.) *Flora of Australia*. Vol. 37. pp. 172–191. (Australian Biological Resources Study: Canberra.)

Katoh, K. & Standley, D.M. (2013). MAFFT Multiple Sequence Alignment Software Version 7: Improvements in Performance and Usability. *Molecular Biology and Evolution* 30: 772–780.

Keeley, S.C. & Robinson, R. (2009). Vernonieae. *In*: Funk, V.A., Susanna, F., Stuessy, T.F. & Bayer, R.J. (eds) *Systematics, evolution, and biogeography of Compositae*. pp. 439–469. (International Association for Plant Taxonomy: Vienna.)

Lander, N.S. & Hurter, P.J.H. (2013). *Pleurocarpaea gracilis* (Asteraceae: Vernonieae), a new species from the Pilbara region of Western Australia. *Nuytsia* 23: 109–115.

Schilling, E.E. (2011). Systematics of the *Eupatorium album* Complex (Asteraceae) from Eastern North America. *Systematic Botany* 36: 1088–1100.

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 6 February 2018].

Stamatakis, A. (2014). RAxML version 8: a tool for phylogenetic analysis and post-analysis of large phylogenies. *Bioinformatics* 30: 1312–1313.

White, T.J., Bruns, T., Lee, S. & Taylor, J. (1990). Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. *In*: Innis, M., Gelfand, D., Sninsky, J. & White, T. (eds) *PCR protocols: A guide to methods and applications*. pp. 315–322. (Academic Press: San Diego.)

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SHORT COMMUNICATION

Hydrocotyle eichleri, *H. papilionella* and *H. tuberculata* (Araliaceae), three new annual species from Western Australia

Three new species of *Hydrocotyle* L. from the south-west of Western Australia are described and illustrated herein. All three species were previously given manuscript names by Hansjörg Eichler in the 1970s and 1980s but were never published. They differ from most members of the genus in being annuals with ebracteate umbellate inflorescences and ornately papillate fruits with conspicuously raised and incurved lateral ribs, distinctly concave 'pits' between the lateral and median ribs and a persistent subulate carpophore. They share most of these characters with the widespread Australian species *H. callicarpa* Bunge but that species lacks papillae on its fruits (Figure 1). A key is provided to these four species. All of the new species currently have conservation priority.

Key to Western Australian species of *Hydrocotyle* allied to *H. callicarpa*

1. Schizocarps broadest at the centre, unwinged, with a cordate base

2. Mericarps lacking papillae ..... **H. callicarpa**

2: Mericarps with two or more papillae

3. Many papillae between the dorsal, lateral and median ribs ..... **H. tuberculata**

3: Two (rarely three) papillae in a pit between the lateral and median ribs ..... **H. eichleri**

1: Schizocarps broadest towards the summit, where there are projecting wings, with a truncate base ..... **H. papilionella**

Hydrocotyle eichleri A.J.Perkins, *sp. nov.*

Type: inland lake west-north-west of Esperance, Western Australia [precise location withheld for conservation reasons], 14 September 1998, *M.N. Lyons & S.D. Lyons* 4890 (*holo*: PERTH 08933529; *iso*: MEL).

Hydrocotyle crassipes H.Eichler ms, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 26 January 2018].

Hydrocotyle sp. Crassipes (K.R. Newbey 7567), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 26 January 2018].

Annual herbs consisting of a basal rosette of leaves and branched stems bearing leaves and umbellate inflorescences, 1–5 cm high and 1–6 cm wide. *Stems* ascending, yellowish green to pale crimson, terete, glabrous. *Stipules* white to cream, oblanceolate to linear lanceolate, 0.8–2.0 mm long, 0.8–1.2 mm wide, membranous, translucent, entire to irregularly toothed along margins. *Petioles* yellowish green to pale crimson, 1.5–7.5 mm long, glabrous. *Leaf blades* simple, dorsiventral, carnose, trilobed to palmatifid, 2.0–6.0 mm long, 2.0–7.5 mm wide; adaxial surface green to yellowish green to pale crimson, glabrous; abaxial surface slightly paler in colour than adaxial, glabrous. *Leaf margins*

https://florabase.dpaw.wa.gov.au/nuytsia/ ISSN 2200-2790 (Online) ISSN 0085-4417 (Print)

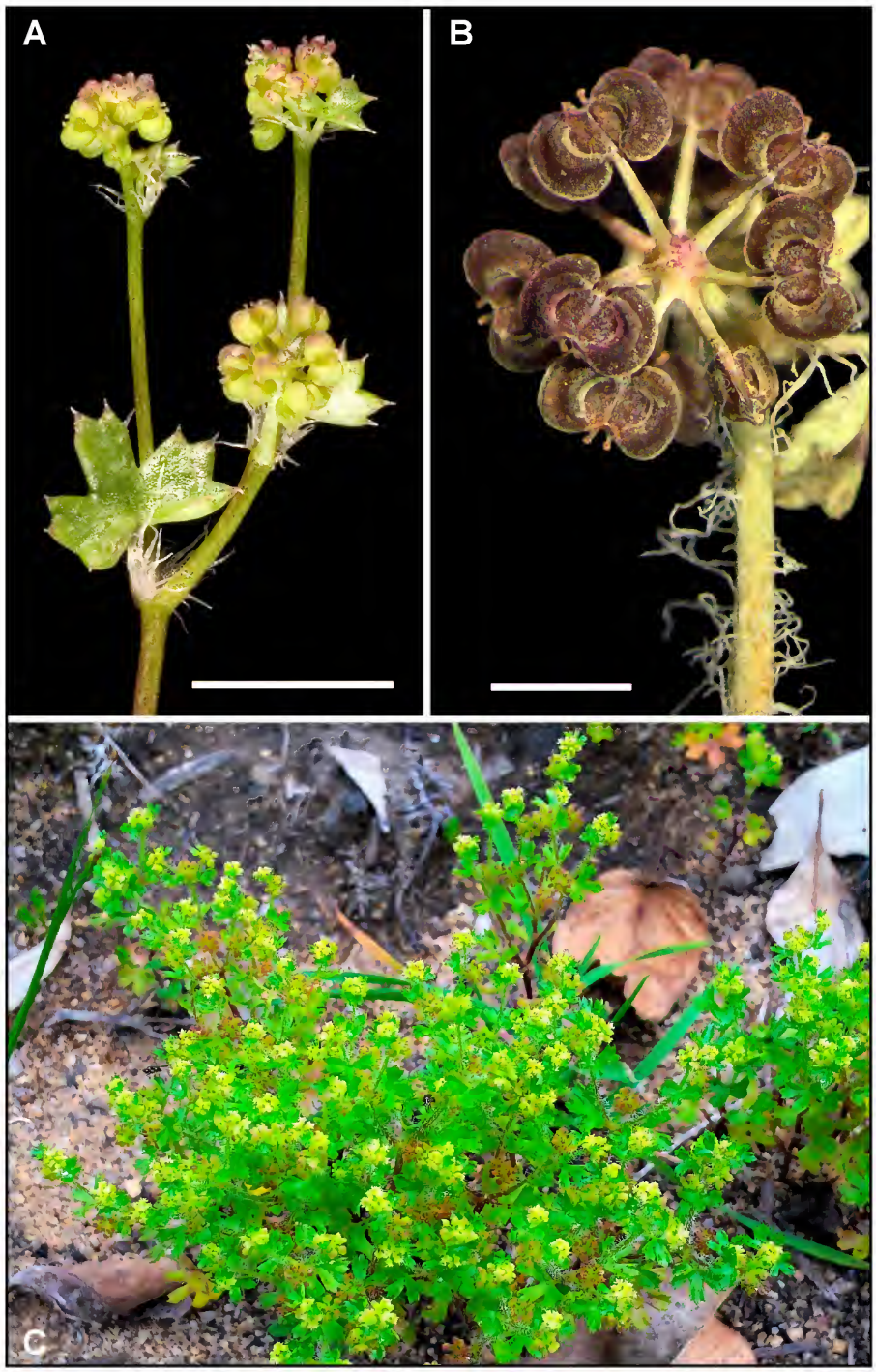

Figure 1. *Hydrocotyle callicarpa*. A – portion of flowering plant showing leaves with hairs on the laminas and tips of marginal teeth, stipules with distinctly ciliate margins, and orbicular umbellate inflorescences; B – infructescence with mature schizocarps; C – fertile plants growing *in situ*. Scale bars = 10 mm (A); 2 mm (B). Vouchers: *K. Thiele* KRT 3374 (PERTH 07893043) (A); *A.J. Perkins & R. Davis* AJP-WA 108 (PERTH 08726493) (B, C). Photographs by K. Thiele (A); A. Perkins (B, C).

toothed; teeth obtuse to acute. *Median leaf lobes* ovate to oblanceolate, 2.0–4.0 mm long, 1.5–2.5 mm wide, with 1–3 teeth. *Lateral leaf lobes* 2.0–4.5 mm long, 1.5–2.5 mm wide, with 1–3 marginal teeth, incised into 2 asymmetrical lobules in palmatifid leaves; leaf sinuses 20–60% of lateral leaflet length. *Inflorescences* leaf-opposed, simple umbels, orbicular, anthesis centripetal, 6–14-flowered, 2.0–3.5 mm wide. *Peduncles* terete to subterete, shorter than subtending leaf at anthesis, becoming equal to or slightly longer than subtending leaf when in fruit, 0.5–4.0 mm long, glabrous. *Involucral bracts* absent. *Pedicels* yellowish green to pale crimson, subterete, longitudinally flattened, 0.1–0.4 mm long. *Flowers* all hermaphrodite, protandrous. *Sepals* absent. *Petals* 5, cream with pale pink to crimson on the abaxial surface (towards the apex), ovate, 0.3–0.6 mm long, 0.3–0.5 mm wide. *Filaments* pale cream, 0.3 mm long. *Anthers* creamy yellow, orbicular to elliptic, 0.1–0.2 mm long. *Ovaries* pale green at anthesis, bilaterally flattened, orbicular, dorsal and lateral ribs raised in profile. *Fruiting pedicels* 0.4–0.8 mm long. *Schizocarps* bilaterally flattened, symmetrical, broadest at the middle (in lateral view), cordate at the base; commissure 95% the length of mericarps. *Mericarps* pale green turning to crimson to dark reddish brown at maturity, 0.6–0.8 mm long, 0.7–0.8 mm wide, smooth to minutely verrucate; dorsal rib prominent, keeled; lateral ribs conspicuously raised, incurved towards median ribs; mericarp surface between dorsal and lateral ribs flattened, glabrous; surface between lateral and median ribs deeply concave, margin of pit with a thickened reddish orange or reddish brown rim, centre of concave pit with 2 (rarely 3) papillae. *Carpophores* persistent, subulate, 0.5 mm long. *Fruiting styles* slightly swollen at the base, 0.3 mm long, erect to partially reflexed. *Cotyledons* oblong to oblanceolate in the seedlings. (Figure 2)

Diagnostic features. *Hydrocotyle eichleri* can be distinguished from all other taxa in *Hydrocotyle* by possessing the following combination of characters: ascending to erect annual herbs up to 5 cm high with relatively thick (and glabrous) stems, petioles, peduncles and pedicels; stipules with few teeth or entire margins; schizocarps cordate at the base, with thickened lateral ribs that are raised and incurved towards the median ribs; mericarps glabrous between dorsal and lateral ribs and with a deep concave pit between lateral and median ribs, the pit with a rimmed margin and 2(3) papillae at the centre (see Figure 2C); carpophores persistent and subulate.

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 6 Oct. 1994, *R.J. Bayer* WA 94083 (ALTA, PERTH); 3 Oct. 1985, *Hj. Eichler* 23772 (CANB); 9 Oct. 1998, *M.N. Lyons & S.D. Lyons* 3887 (PERTH); 1890, *E. Merall s.n.* (MEL 0008336); 22 Sep. 1980, *K.R. Newbey* 7567 (PERTH); 7 Oct. 1981, *K.R. Newbey* 9245 (CANB, PERTH); 4 Sep. 1967, *P.G. Wilson* 6185 (AD, PERTH); 29 Sep. 1970, *P.G. Wilson* 9985 (PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from September to October.

Distribution and habitat. *Hydrocotyle eichleri* is currently known from nine general localities, scattered north–south for approximately 400 km, from Lake Deborah area in the north, to the Esperance region in the south and east-west for approximately 400 km, from Dundas Nature Reserve in the east, to the Bruce Rock area in the west (Figure 3). This species grows in sandy loam soils surrounding the margins of inland salt lakes and saline pans (Figure 2D).

Conservation status. *Hydrocotyle eichleri* is listed as Priority Three under Conservation Codes for Western Australian Flora, under the name *Hydrocotyle* sp. Crassipes (K.R. Newbey 7567) (Smith & Jones 2018).

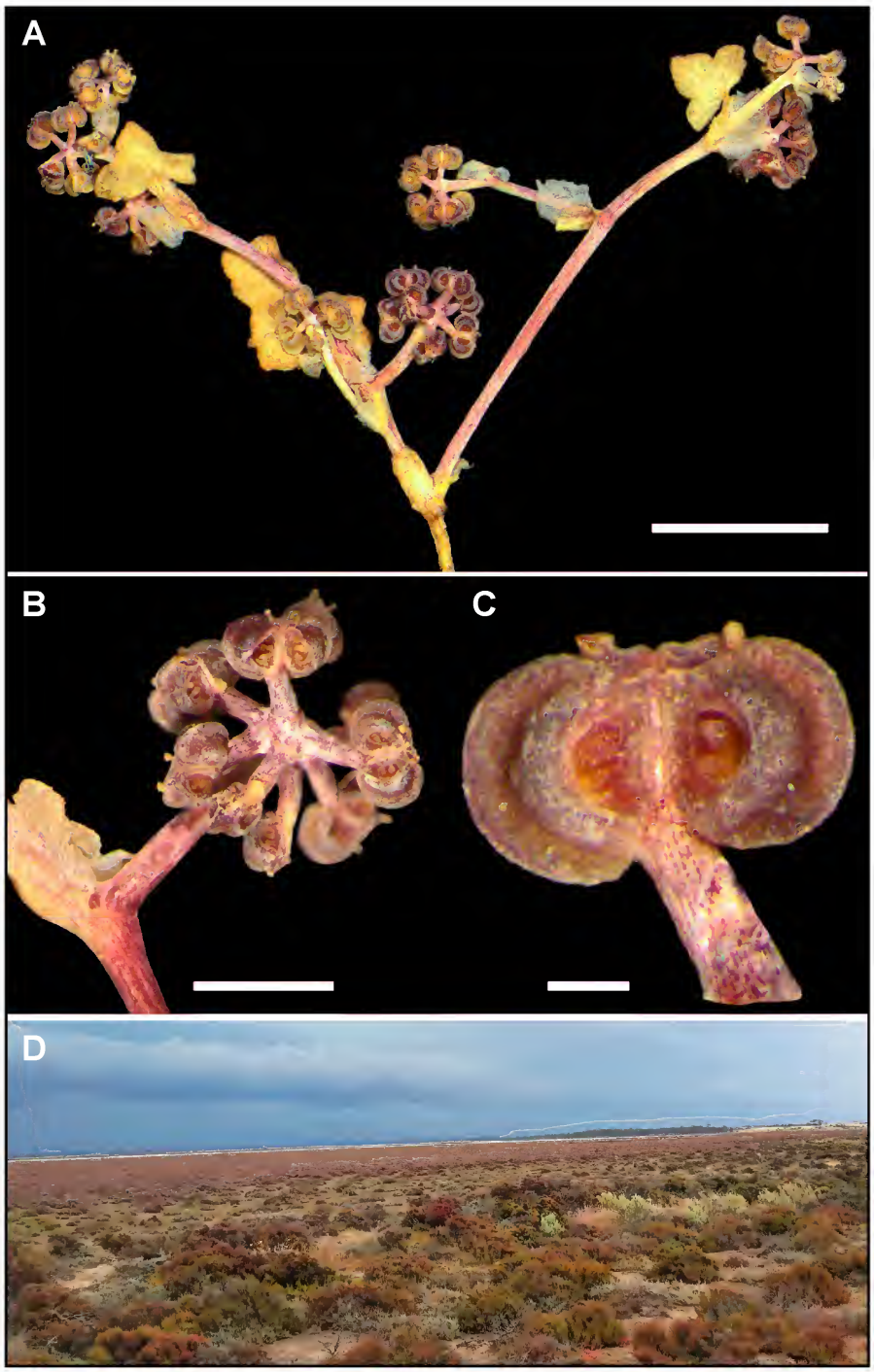

Figure 2. *Hydrocotyle eichleri*. A – herbarium voucher showing flowers and developing fruits borne in simple umbels; B – infructescence showing the relatively thick stem, peduncle and pedicels; C – lateral view of a mature schizocarp showing prominently raised and thickened lateral ribs that are incurved, surrounding 2 concave pits, each containing 2 papillae; D – typical habitat. Scale bars = 5 mm (A); 1 mm (B); 0.1 mm (C). Voucher: *M.N. Lyons & S.D. Lyons* 4890 (A–C). Photographs by A. Perkins.

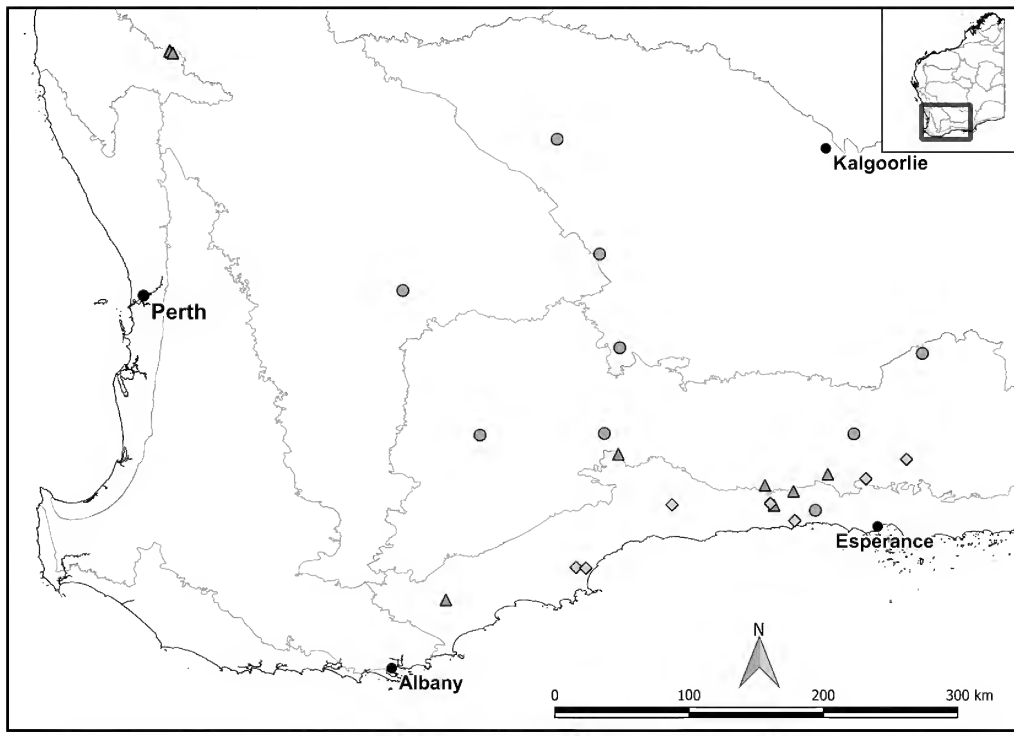

Figure 3. Distribution of *Hydrocotyle eichleri* (●), *H. papilionella* (▲) and *H. tuberculata* (◆) based on selected specimens held at CANB, MEL, NSW and PERTH. Map with *Interim Biogeographic Regionalisation for Australia* version 7 bioregions (Department of the Environment 2013) shown in grey. Based on specimen data from Western Australian Herbarium (1998–) and AVH (2017).

Etymology. The specific epithet honours the late Hansjörg Eichler (1916–1992) in recognition of his significant contribution to the taxonomy of *Hydrocotyle* (Eichler 1965, 1987a, 1987b, 1987c). The common name, 'Eichler's Pennywort' is here suggested.

Affinities. *Hydrocotyle eichleri* is morphologically similar to the widespread winter annual *H. callicarpa* and the two rare Western Australian annuals *H. papilionella* A.J.Perkins and *H. tuberculata* A.J.Perkins. All four species possess ebracteate umbellate inflorescences, fruits with conspicuously raised and incurved lateral ribs, distinctly concave 'pits' between the lateral and median ribs, and persistent subulate carpophores.

Hydrocotyle eichleri can readily be distinguished from *H. callicarpa* by having entire to shallowly toothed stipules (distinctly fimbriate in *H. callicarpa*), glabrous leaf laminas (sparsely hairy in *H. callicarpa*), glabrous marginal teeth on the leaf blades (marginal teeth tipped with setose hairs in *H. callicarpa*), relatively thick pedicels (slender pedicels in *H. callicarpa*), the mericarp surface between the lateral and median ribs containing a conspicuous concave pit with a rimmed margin and two papillae in the centre of each pit (glabrous and lacking rimmed pits in *H. callicarpa*) (See Figures 1B, 2A, B). Both *H. papilionella* and *H. tuberculata* share the characters of having glabrous stems, leaves and peduncles, as well as papillate mericarp surfaces with *H. eichleri*. They both differ from *H. eichleri* in that they have papillate mericarp surfaces between the dorsal and lateral ribs (glabrous in *H. eichleri*) and the fruit lack rimmed pits (Figures 2C, 4B, 5B).

Hydrocotyle papilionella A.J.Perkins, *sp. nov.*

Type: south-east of Coorow, Western Australia [precise locality withheld for conservation reasons], 26 September 1999, *M.N. Lyons & S.D. Lyons* 4891 (*holo*: PERTH 08933510; *iso*: MEL).

Hydrocotyle vigintimilia H.Eichler ms, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 26 January 2018].

Hydrocotyle sp. Vigintimilia (P.G. Wilson 7940), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 26 January 2018].

Annual herbs consisting of 2–5 basal leaves and branched stems bearing leaves and umbellate inflorescences, 1.5–6.0 cm high and 1–7 cm wide. *Stems* erect to ascending, pale green to reddish green, terete, glabrous. *Stipules* cream to light creamy brown, elliptic to broadly ovate, 0.8–2.0 mm long, 0.5–1.5 mm wide, membranous, translucent, irregularly toothed to occasionally entire along margins. *Petioles* pale green to reddish green, 0.4–5.0 mm long, glabrous. *Leaf blades* simple, dorsiventral, carnose, rhombic to shallowly trilobed in juvenile leaves, trilobed to occasionally palmatifid in mature leaves, 1.2–2.6 mm long, 1.2–4.5 mm wide; adaxial surface light green, glabrous; abaxial surface slightly paler in colour than adaxial, glabrous. *Leaf margins* toothed; teeth mostly rounded to obtuse or occasionally acute. *Median leaf lobes* ovate to oblanceolate, 1.2–2.6 mm long, 0.8–1.7 mm wide, with 1 marginal tooth. *Lateral leaf lobes* 1.5–2.3 mm long, 0.7–1.8 mm wide, with 1–3 marginal teeth; leaf sinuses 20–50% of lateral leaflet length. *Inflorescences* leaf-opposed, simple umbels, anthesis centripetal, 3–8-flowered, 2–3 mm wide. *Peduncles* terete, much shorter than opposing leaf at anthesis, becoming as long or longer than subtending leaf when in fruit, 0.2–4.5 mm long, glabrous. *Involucral bracts* absent. *Pedicels* light green, subterete, longitudinally flattened, 0.1–0.3 mm long. *Flowers* all hermaphrodite, protandrous. *Sepals* absent. *Petals* 5, cream with pale pink to crimson on the abaxial surface towards the apex, ovate, 0.4–0.6 mm long, 0.3–0.4 mm wide. *Filaments* pale cream, 0.3–0.4 mm long. *Anthers* creamy yellow or occasionally crimson, elliptic, 0.2 mm long. *Ovaries* pale green at anthesis, bilaterally flattened, broadly obcordate, dorsal and lateral ribs raised in profile. *Fruiting pedicels* 0.2–0.8 mm long. *Schizocarps* bilaterally flattened, symmetrical, broadest towards the summit (in lateral view) such that they appear butterfly-shaped, truncate at the base; commissure 95% the length of mericarps. *Mericarps* light green turning dark brown at maturity, 0.7–0.8 mm long, 0.6–0.7 mm wide, minutely verrucate to colliculate; dorsal rib conspicuous, winged at maturity; wing above the midpoint of the dorsal rib and protruding 0.1–0.2 mm from it, pale brown, shallowly triangular, obtuse to acute or occasionally notched; lateral ribs prominently thickened and raised, slightly incurved towards median ribs; surface between dorsal and lateral ribs flattened, with a longitudinal row of 4–8 papillae adjacent to the raised lateral rib; surface between lateral and median ribs deeply concave, with a row of 3–5 papillae adjacent to lateral rib. *Carpophores* persistent, subulate, 0.5–0.6 mm long. *Fruiting styles* slender at the base, 0.2 mm long, porrect. *Cotyledons* elliptic to oblanceolate in the seedlings. (Figure 4)

Diagnostic features. *Hydrocotyle papilionella* can be distinguished from all other taxa in *Hydrocotyle* by possessing the following combination of characters: ascending to erect annual herbs up to 6 cm high with glabrous stems, petioles, leaves and peduncles; stipules with few teeth or entire along margins; subsessile to shortly pedunculate umbels bearing 3–8 flowers; schizocarps truncate at the base, with a slender angular wing along the dorsal ribs, raised lateral ribs that are incurved towards the median ribs; mericarps flattened between dorsal and lateral ribs, with a longitudinal row of 4–8 papillae adjacent to the raised lateral rib, and deeply concave between lateral and median ribs, with a row of 3–5 papillae adjacent to lateral rib (see Figure 4B); carpophores persistent and subulate.

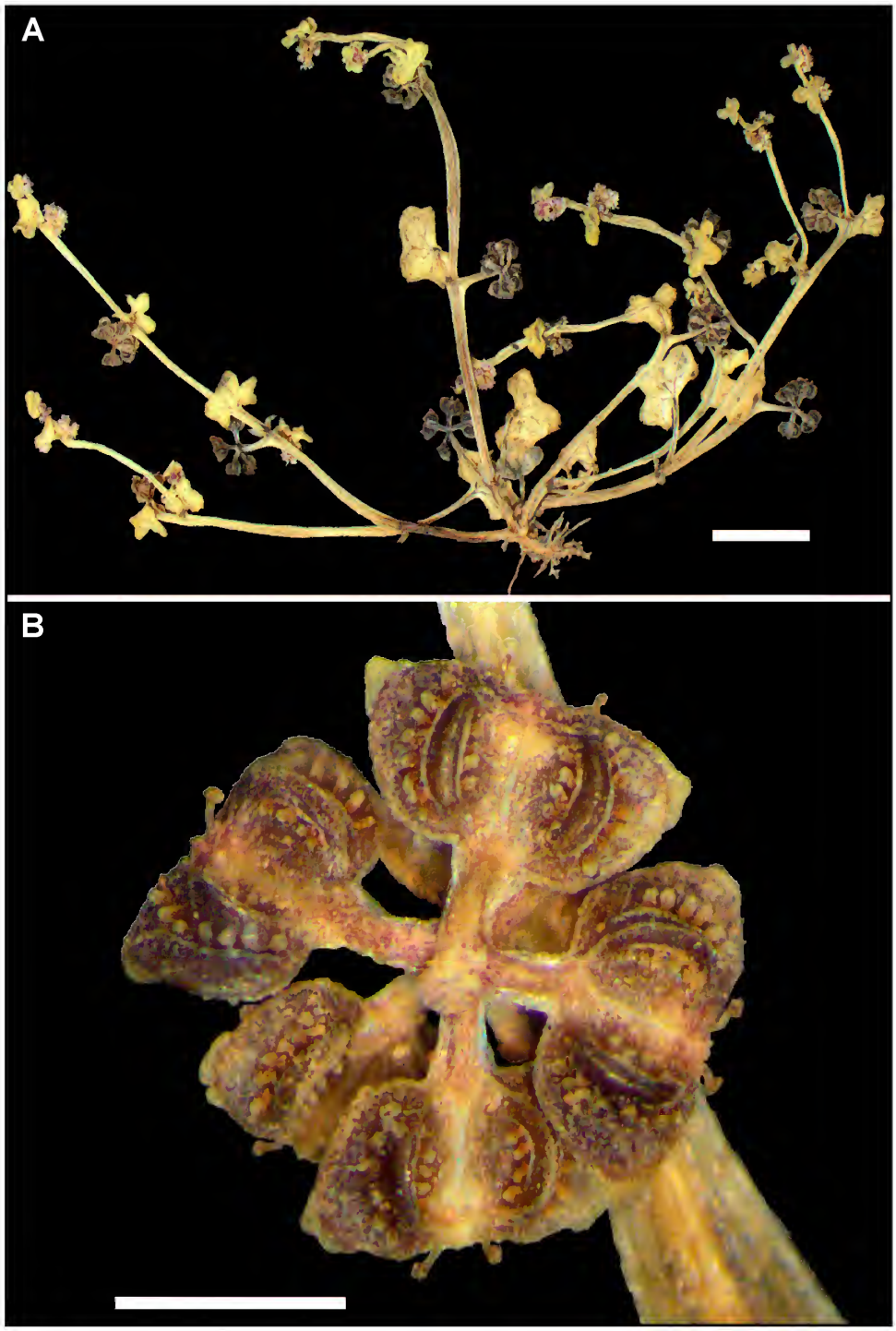

Figure 4. *Hydrocotyle papilionella*. A – herbarium voucher showing flowers and developing fruits borne on simple umbels; B – mature infructescence showing winged schizocarps with distinctive longitudinal rows of papillae either side of the raised lateral ribs. Scale bars = 5 mm (A); 1 mm (B). Voucher: *M.N. Lyons & S.D. Lyons* 4891 (A, B). Photographs by A. Perkins.

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 14 Oct. 1968, *N.N. Donner* 3029 (CANB); 27 Sep. 1968, *Hj. Eichler* 20000 (CANB); 10 Sep. 1971, *Hj. Eichler* 21160 (CANB); 11 Sep. 1985, *Hj. Eichler* 23675 (CANB, PERTH); 22 Sep. 1998, *E.M. Sandiford* 247 (PERTH); 1 Nov. 2016, *E.M. Sandiford & S. Barrett* 2316 (PERTH); 24 Oct. 1983, *P.S. Short* 2204 (MEL); 26 Sep. 1968, *P.G. Wilson* 7940 (PERTH).

Phenology. This species is a winter annual, with flowering and fruiting occurring from September to November.

Distribution and habitat. *Hydrocotyle papilionella* is currently known from seven general localities with a large north–south disjunction in populations of around 540 km (Coorow to Mt Madden). The six southern populations are spread over 310 km, from Scaddan south-west to the Stirling Range (Figure 3). This species grows in damp loam soils surrounding the margins of inland salt lakes and in damp granitic sandy loams surrounding exposed granite outcropping.

Conservation status. *Hydrocotyle papilionella* is listed by Smith and Jones (2018) as Priority One under Conservation Codes for Western Australian Flora, under the name *H.* sp. Vigintimilia (P.G. Wilson 7940).

Etymology. The epithet is derived from the Latin '*papilio*' (genitive *papilionis*) and means 'a small butterfly', which is a reference to the lateral profile of the fruit (Figure 4B). The common name, 'Butterfly Pennywort' is here suggested.

Affinities. *Hydrocotyle papilionella* can be readily distinguished from *H. callicarpa*, *H. eichleri* and *H. tuberculata* by having schizocarps that are broadest towards the summit (compared to broadest at the centre) with projecting angular wings and truncate bases, thus giving the fruit their distinctive butterfly-shaped appearance (Figure 4). Additionally, the papillae on each mericarp in *H. papilionella*, are characteristically arranged in two longitudinal rows, each (row) separated by the raised lateral rib (see Figure 4B). *Hydrocotyle papilionella* can be further distinguished from *H. callicarpa* by having entire to shallowly toothed stipules (distinctly fimbriate in *H. callicarpa*), glabrous leaf laminas (sparsely hairy in *H. callicarpa*) and glabrous marginal teeth on the leaf blades (marginal teeth tipped with setose hairs in *H. callicarpa*) (See Figures 1, 4).

Hydrocotyle tuberculata A.J.Perkins, *sp. nov.*

Type: south-east of Scaddan, Western Australia [precise locality withheld for conservation reasons], 20 October 2017, *A.J. Perkins* AJP-WA 139 (*holo*: PERTH 08935041; *iso*: AD, CANB, MEL).

Hydrocotyle decipiens H.Eichler ms, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 26 January 2018].

Hydrocotyle sp. Decipiens (G.J. Keighery 463), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 26 January 2018].

Annual herbs consisting of a basal rosette of leaves and branched stems bearing leaves and umbellate inflorescences, 2–10 cm high and 1–18 cm wide. *Stems* ascending, reddish green to crimson, terete, glabrous. *Stipules* white, lanceolate to broadly ovate, 0.7–2.5 mm long, 0.5–1.4 mm wide, membranous, translucent, incised to laciniate along margins. *Petioles* reddish green to crimson, 1.5–25.0 mm long, glabrous or rarely subglabrous. *Leaf blades* simple, dorsiventral, carnose, trilobed to palmatifid,

1.5–9.0 mm long, 2.0–12.5 mm wide; adaxial surface green to reddish green, glabrous; abaxial surface slightly paler in colour than adaxial, glabrous or rarely subglabrous. Leaf margins toothed; teeth mostly rounded to obtuse, rarely acute. *Median leaf lobes* ovate to oblanceolate, 1.5–5.0 mm long, 1.0–3.5 mm wide, with 1–3 teeth. *Lateral leaf lobes* 1.1–4.5 mm long, 0.8–4.5 mm wide, with 1–6 marginal teeth, incised into 2 asymmetrical lobules in palmatifid leaves; leaf sinuses 20–80% of lateral leaflet length. *Inflorescences* leaf-opposed, simple umbels, anthesis centripetal, 3–22-flowered, 1.5–3.0 mm wide. *Peduncles* terete, shorter than subtending leaf at anthesis, becoming predominantly longer than subtending leaf or occasionally remaining subsessile when in fruit, 0.4–20.0 mm long, glabrous. *Involucral bracts* absent. *Pedicels* green to reddish green, subterete, longitudinally flattened, 0.2–0.4 mm long. *Flowers* all hermaphrodite, protandrous. *Sepals* absent. *Petals* 5, cream with pale pink to crimson on the abaxial surface (towards the apex), ovate, 0.5–0.6 mm long, 0.2–0.3 mm wide. *Filaments* pale cream, 0.3 mm long. *Anthers* creamy yellow, elliptic, 0.2 mm long. *Ovaries* pale green at anthesis, bilaterally flattened, orbicular, dorsal and lateral ribs raised in profile. *Fruiting pedicels* 0.5–1.6 mm long. *Schizocarps* bilaterally flattened, symmetrical, broadest at the middle (in lateral view), cordate at the base; commissure 95% the length of mericarps. *Mericarps* green turning crimson to dark reddish brown at maturity, 0.6–0.7 mm long, 0.5–0.6 mm wide, tuberculate; dorsal rib prominent, keeled; lateral ribs conspicuously raised, slightly incurved towards median ribs; surface between dorsal and lateral ribs flattened, covered with papillae; surface between lateral and median ribs concave, densely covered with papillae. *Carpophores* persistent, subulate, 0.3–0.6 mm long. *Fruiting styles* slender at the base, 0.2–0.3 mm long, erect to fully reflexed. *Cotyledons* elliptic to ovate in the seedlings. (Figure 5)

Diagnostic features. *Hydrocotyle tuberculata* can be distinguished from all other taxa in *Hydrocotyle* by possessing the following combination of characters: ascending annual herbs up to 10 cm high, often with reddish green to crimson stems, leaves, peduncles and pedicels; stipules with few teeth or entire along margins; simple umbels bearing 3–22 flowers; schizocarps cordate at the base, with raised lateral ribs that are incurved towards the median ribs; mericarps tuberculate between dorsal and lateral ribs, distinctly concave and tuberculate between lateral and median ribs (see Figure 5B); carpophores persistent and subulate.

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 31 Oct. 2005, *G.F. Craig* 6943 (PERTH); 31 Oct. 2005, *G.F. Craig* 6948 (PERTH); 10 Oct. 1968, *Hj. Eichler* 20169 (CANB); 1 Nov. 1975, *G.J. Keighery* 463 (PERTH); 7 Sep. 1971, *E.F Melville & R. Melville* 71.195 (NSW); 13 Oct. 2007, *A.J. Perkins s.n.* (NSW, PERTH 08012806, SYD); 6 Oct. 1970, *P.G. Wilson s.n.* (PERTH 03539830).

Phenology. This species is a winter annual, with flowering and fruiting occurring from September to November.

Distribution and habitat. *Hydrocotyle tuberculata* is currently known from seven general localities spread east–west over 250 km from the Mt Ridley area to Fitzgerald River National Park (Figure 3). This species grows in damp sandy loam soils associated with winter-moist creeklines and drainage areas associated with inland saline lakes (Figure 5C).

Conservation status. *Hydrocotyle tuberculata* is listed by Smith and Jones (2018) as Priority Two under Conservation Codes for Western Australian Flora, under the name *Hydrocotyle* sp. Decipiens (G.J. Keighery 463).

Etymology. The epithet *tuberculata* is derived from the Latin '*tuberculatus*', with tubercles or bumps,

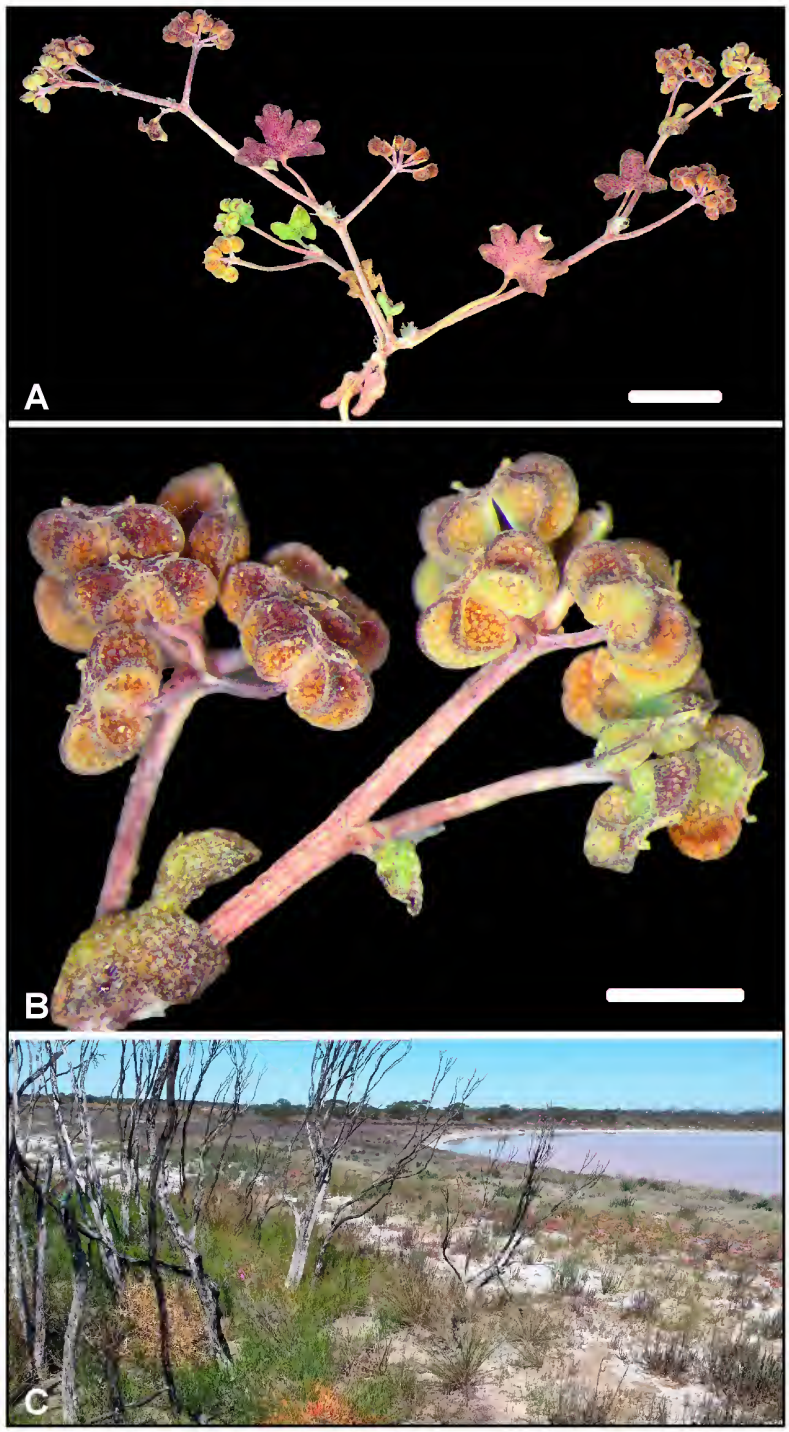

Figure 5. *Hydrocotyle tuberculata*. A – herbarium voucher showing flowers and developing fruits borne on simple umbels; B – maturing infructescences showing tuberculate schizocarps with the distinctive raised and incurved lateral ribs; C – typical habitat adjacent to an inland salt lake. Scale bars = 5 mm (A); 1 mm (B). Voucher: *A.J. Perkins* AJP-WA 139 (A, B). Photographs by A. Perkins.

in reference to the numerous tubercles (papillae) on the mericarp surfaces (Figures 5B). The common name, 'Bumpy-fruited Pennywort' is here suggested.

Affinities. *Hydrocotyle tuberculata* can be readily distinguished from *H. callicarpa*, *H. eichleri* and *H. papilionella* by having many papillae on mericarp surfaces between the dorsal, lateral and median ribs (Figure 5B). In the field, mature plants are reddish green to dark crimson in colour, including the ripening fruit. *Hydrocotyle tuberculata* differs from *H. papilionella* by its wingless schizocarps (Figure 4B) and differs from *H. eichleri* by the lack of a rim surrounding the concave 'pits' between the lateral and median ribs (Figure 2C). Additionally, *H. tuberculata* differs from *H. callicarpa* by having stipules with incised to laciniate margins (stipules prominently fimbriate in *H. callicarpa*), glabrous leaf laminas (sparsely hairy in *H. callicarpa*) and glabrous marginal teeth on the leaf blades (teeth tipped with setose hairs in *H. callicarpa*) (Figures 1, 5).

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References

AVH (2017). *The Australasian Virtual Herbarium*, Council of Heads of Australasian Herbaria. https://avh.chah.org.au/ [accessed 26 January 2018].

Department of the Environment (2013). *Australia's bioregions (IBRA)*, IBRA7, Commonwealth of Australia. http://www.environment.gov.au/land/nrs/science/ibra#ibra [accessed 26 January 2018].

Eichler, H. (1965). *Supplement to J.M. Black's Flora of South Australia* (Second Edition, 1943–1957). pp. 248–249. (Government Printer, Adelaide, South Australia.)

Eichler, H. (1987a). Nomenclatural and bibliographical survey of *Hydrocotyle* L.(Apiaceae). Part 1. *Feddes Repertorium* 98:1–51

Eichler, H. (1987b). Nomenclatural and bibliographical survey of *Hydrocotyle* L.(Apiaceae). Part 2. *Feddes Repertorium* 98:145–196

Eichler, H. (1987c). Nomenclatural and bibliographical survey of *Hydrocotyle* L.(Apiaceae). Part 3. *Feddes Repertorium* 98:273–350

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora List, 16 January 2018*. Department of Biodiversity, Conservation and Attractions: Kensington, WA [accessed 1 February 2018].

Western Australian Herbarium (1998–). *FloraBase—the Western Australian Flora*. Department of Biodiversity, Conservation and Attractions. https://florabase.dpaw.wa.gov.au/ [accessed 26 January 2018].

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SHORT COMMUNICATION

Livistona leichhardtii is the correct name for *Livistona lorophylla* (Arecaceae)

Livistona R.Br. is the most speciose genus of palms in Australia, with 18 indigenous species (Dowe & Jones 2011). Although the taxonomy, nomenclature and typification of *Livistona* species have been relatively stabilised by recent treatments (Rodd 1998; Dowe 2009, 2010) a number of issues with regards to status and nomenclature have remained unresolved. Examination of a number of names in synonymy has shown that the identity and status of the name *L. leichhardtii* F.Muell. has been misapplied and is the correct name for *L. lorophylla* Becc., a species occurring in Western Australia and the Northern Territory.

Ferdinand Mueller, the Victorian Government Botanist, was appointed to the North Australian Expedition of 1855–56, commanded by A.C. Gregory (Gregory 1858; Mueller 1858a; Gregory & Gregory 1884). The expedition sailed from Brisbane on 11 August 1855, landed briefly on islands off the east Queensland coast before proceeding to Port Essington, and then to Victoria River where the party landed on 16 September 1855. During the following eight months, the expedition traversed Macadam Range and then thoroughly explored the Victoria River/Sturt Creek area to as far inland as Lake Gregory [20° 12' S, 127° 27' E] before proceeding eastward to the Gulf of Carpentaria on 21 June 1856. After travelling through Queensland (then still New South Wales) following mainly the Nicholson, Gilbert, Burdekin, Suttor, Belyando, Mackenzie and Dawson Rivers, the expedition terminated in Brisbane on 13 December 1856.

There are three known specimens of *Livistona* that were collected by Mueller during the expedition, two from Victoria River area labelled by him as '*Livistona* fruit ovate Arnhem's Land, Mcadam's Range 1855' (MEL 1059368) and '*Livistona* ? *leichhardtii* F.Muell. Arnhem's Land Dr. Ferd. Mueller' (MEL 1059501), and one from the Gulf of Carpentaria labelled as '*Livistona* Albert River Ferd. Mueller' (K 000209824). This latter taxon was subsequently named as *L. rigida* Becc., and is not otherwise involved in this investigation. Mueller used the term 'Arnhem's Land' to denote the entire northern portion of northern central Australia (then New South Wales) and not the east portion of the 'Top End' as used today. Mueller's use of the name Macadam Range also needs to be considered. The concise delineation of Macadam Range on modern maps is restricted to the north of Fitzmaurice River, although Mueller appears to have also used the name for the elevated landforms between Fitzmaurice River and Victoria River.

In his botanical report for the expedition, Mueller (1858b) wrote that '*Livistona inermis* and an allied species supplied us occasionally with palm cabbage' and that the 'sandstone tableland forms in its endless extent a landscape equally arid and cheerless … *Livistona inermis* gracing now and then its declivities'. In the 'Systematic Listing' appended to his report, Mueller noted that *Livistona* was represented by two species ['Palmae … *Livistona* … 2'], but did not provide any specific names, designations or descriptions.

Mueller's interpretation of *L. leichhardtii*

At the time of the North Australian Expedition, the taxonomic understanding of Australian species of *Livistona* was rudimentary, with only three species thus far described: *L. humilis* R.Br., *L. inermis* R.Br. and *L. australis* (R.Br.) Mart. (Brown 1810; Martius 1838). *Livistona leichhardtii* was subsequently described by Mueller (1874a, 1874b) thus providing a fourth species for the genus in Australia.

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Historically there have been different appraisals concerning the identities of *L. humilis*, *L. inermis* and *L. leichhardtii*. Brown (1810) described *L. inermis* [*frondis laciniis filis interjectis; stipitibus inermibus, caudice 14–30–pedali*] and *L. humilis* [*frondis laciniis filis interjectis; stipitibus spinosis, caudice 4–6–pedali*] from islands in the Gulf of Carpentaria, and their descriptions, because of their brevity, were open to interpretation. Martius (1838), with additional specimens at hand, gave detailed descriptions of both of Brown's species and clearly circumscribed their characteristics and differences. The first formal proposal to place *L. humilis* as a synonym of *L. leichhardtii* was provided by Wendland and Drude (1875) in *Palmae Australasicae*, but they maintained the name *L. inermis* as a distinct species (though not directly referable to Brown's *L. inermis* but to what was later to be described as *L. decora* (W.Bull) Dowe). Bentham (1878), in his treatment of palms in *Flora Australiensis*, took a different approach and placed *L. leichhardtii* as a synonym of *L. humilis*, but also maintained *L. inermis* as distinct (but tendered that it 'may prove to be a variety only of *L. humilis*'). Mueller (1878: 55), in a summary of Australian palms, wrote '*Livistona Leichhardtii forsan includit L. inermem et L. humilem; neutrius Brownianae nomen toti speciei aptum*' [translates as: '*Livistona leichhardtii* may include *L. inermis* and *L. humilis*; neither of Brown's names fit well to this species'], thus questioning what name should apply but otherwise not making any formal changes. However, in his *Systematic Census of Australian Plants*, Mueller (1882) listed both *L. inermis* and *L. humilis*, but did not include *L. leichhardtii*. In contrast, in his *Select Extra-Tropical Plants*, Mueller (1885: 202) noted for *L. leichhardtii* that 'Under this name might be combined *L. inermis* and *L. humilis* (R. Brown), neither name applying well to this finally tall palm with thorny leaf-stalks'. Subsequently, Mueller (1889) was to maintain this position in the *Second Census of Australian Plants*, excluding both *L. inermis* and *L. humilis* but listing *L. leichhardtii* in their place. To summarise his assessment, Mueller (1892: 652) wrote: 'When in 1856 I saw a tall *Livistona* far in the interior of Arnhem's-land, evidently the same which Leichhardt noticed there in 1845, I gave it the name of that lamented geographer, because it agreed not with the short diagnosis given by R. Brown and by Kunth for the tropic Austral Livistonas, and when I subsequently became almost convinced, so far as I here could judge, that *L. humilis* is a youthful *L. inermis*, I kept up the name *L. leichhardtii* for the united species, their original names having become inapplicable now'. Drude (1893) followed Mueller's interpretation placing both *L. inermis* and *L. humilis* as synonyms of *L. leichhardtii*. Beccari (1921) in his detailed synopsis of *Livistona*, followed Bentham's previous proposal and placed *L. leichhardtii* as a synonym of *L. humilis*, retained *L. inermis* as distinct and recognised *L. lorophylla*. The most recent treatments of *Livistona* also supported this latter arrangement, somewhat uncritically, and the name *L. leichhardtii* had been seemingly 'lost' to synonymy (Rodd 1998; Dowe & Jones 2011).

With his description of *L. leichhardtii*, Mueller indeed established a distinct new taxon unrelated to either *L. inermis* or *L. humilis*. Mueller's protologue description for *L. leichhardtii* most closely resembles *L. lorophylla* (Beccari 1921), the primary characteristics for both being '*Praealta, petiolo spinuloso*' (very tall with spiny petioles) and '*semen ovatum*' (ovate seeds). Morphologically this distinguishes *L. leichhardtii* from *L. inermis*, which has smooth or sub-spiny petioles, and from *L. humilis*, which is a short-statured species.

Status of *Livistona leichhardtii*

To determine the connection between Mueller's specimens and collection locations, a detailed examination of the routes travelled by Mueller during the North Australian Expedition of 1855–56 indicates that he did not visit or travel near any presently known populations of either *L. inermis* or *L. humilis* but that he travelled through Macadam Range where *L. lorophylla* has been reported as occurring, and through the Victoria River area where what he called *L. inermis* was later described

as *L. victoriae* Rodd. It appears that Mueller's use of the name *L. inermis* for *L. victoriae* was possibly in relation to the similarly unarmed petioles of that species, and that his 'allied species' of *Livistona* was what he subsequently described as *L. leichhardtii*.

With regard to the two specimens of *Livistona* that Mueller collected in the Victoria River area, MEL 1059368 and MEL 1059501, both have been identified as *L. humilis* (Rodd 1998; Dowe 2009; Dowe & Jones 2011), determinations that are, given the above information, demonstrably incorrect. Rodd (1998) who designated MEL 1059368 as the lectotype of the name *L. leichhardtii* considered this name to be a taxonomic synonym of *L. humilis*, however there is no evidence that *L. humilis* occurs at Macadam Range or in the Victoria River area, the rugged sandstone habitat not being suitable, and with its closest known occurrence about 50 km to the north-east of Macadam Range.

Unfortunately, both of Mueller's *Livistona* 'Arnhem's Land' specimens are deficient. Neither has leaf material, although both have inflorescence portions and fruit, the latter of which are critical in identifying some north Australian *Livistona* species. The Australian *Livistona* species with ovoid/obovoid fruits include *L. eastonii* C.A.Gardner, *L. humilis*, *L. inermis* and *L. lorophylla*. Other fruit shapes in *Livistona* include globose and ellipsoid. MEL 1059368 has a single ovoid fruit whilst MEL 1059501 has four globose fruit. Mueller described the fruit as 'ovate' in the protologue, which matches with MEL 1059368. It must be noted that Mueller's labelling of MEL 1059501 as 'Livistona ? leichhardtii' is misleading, as the fruit in that specimen are globose and thus being a collection of *L. victoriae*, the only globose-fruited species in the area.

It is understandable therefore that MEL 1059368 could be determined as *L. humilis* on the basis of fruit shape alone, although the collection location discounts that species. *Livistona inermis* can also be discounted as its distribution does not extend south of about Katherine Gorge some 260 km to the east-north-east of Macadam Range. Similarly, *L. eastonii* can be discounted as it occurs some 360 km to the west in the Mitchell Plateau, Western Australia. In regards to MEL 1059501, the specimen with globose fruit, it best matches *L. victoriae*, which apparently Mueller informally interpreted as *L. inermis* (Mueller 1858b).

It is clear that *L. leichhardtii* is distinct from *L. inermis* and *L. humilis* despite Mueller's uncertainty regarding these earlier names. Mueller had a reasonably clear understanding of what constituted his *L. leichhardtii*, as the protologue provided a detailed description. This is supported by Mueller's identification of other specimens. For example, those collected by Johnson in 1885 from 'near Cambridge Gulf' that were later involved in the typification of *L. lorophylla* (Beccari 1921) were originally identified and labelled by Mueller as *L. leichhardtii*. Therefore, with reference to the above explanation and reasoning, *L. leichhardtii* is here proposed as the correct name for *L. lorophylla*, and a revised taxonomy is presented.

Taxonomy

Livistona leichhardtii F.Muell., *Fragm.* 8(68): 221 (1874).

Type citation: '*In Arnhemia et regionibus vicinis, ubi jam Leichhardtio notata.*' *Type specimen*: Macadam Range, Northern Territory, Oct. 1855, *F. Mueller s.n.* (*lectotype*, *fide* A.N. Rodd, *Telopea* 8: 109 (1998): MEL 1059368!).

Note. The specimen MEL 1059501, labelled by Mueller as '*Livistona* ? *leichhardtii* F.Muell. Arnhem's Land Dr. Ferd. Mueller', is here identified as *L. victoriae*, and therefore excluded from the typification

of *L. leichhardtii*. Rodd (1998) appears to have misinterpreted Mueller's two specimens from 'Arnhem's Land', taking on Mueller's incorrectly labelled '*Livistona* ? *leichhardtii*', i.e. MEL 1059501, as representing *L. leichhardtii*, but otherwise correctly identifying the specimen labelled '*Livistona* ... Oct. 1855', i.e. MEL1059368, as the type for the name.

Livistona leichhardtii F.Muell., *Fragm.* 5(33): 49, 234 (1865), *nom. nud.*

Livistona lorophylla Becc., *Webbia* 5: 18 (1921) as *loriphylla*. *Type specimens*: Cambridge Gulf, Western Australia, 1885, *Johnston s.n.* (*holo*: FI!; *iso*: MEL 0067691!, MEL 0067692!, NSW 693019).

Livistona sp. 'A', A.J.G. Wilson, *Fl. Kimberley Region*: 1250 (1992).

Livistona kimberleyana Rodd, *Telopea* 8: 121, Figures 4g, 17d (1998). *Type specimens*: Durack Range, Mt King, Western Australia, 24 Oct. 1974, *A.N. Rodd* 2866 (*holo*: NSW 501606! (sheet 1 of 3), – 501607! (sheet 2 of 3), – 501608! (sheet 3 of 3); *iso*: CANB 549137!, K 000209069!, PERTH 06125972!, PERTH 06125964!).

Solitary-stemmed *palm*, to 15 m tall, 8–20 cm dbh; leafscars raised; internodes narrow, grey; stem base with persistent petiole remnants. *Leaves* 25–40 held in a globose crown; petiole arching, 70–200 cm long, 1–1.7 cm wide, flat on the adaxial surface, margins with small to moderate, scattered, single-curved black spines; leafbase fibres moderately prominent, coarse, persistent; lamina regularly segmented, circular in outline, 60–100 cm long, coriaceous, glossy mid-green to pruinose-grey on both surfaces; segments 34–50, pendulous to flaccid, segments free for 85–98% of their length, depth of apical cleft 55–78% of the length of the free segment; apical lobes semi-pendulous, acuminate to filiform. *Inflorescences* 20–160 cm long; partial inflorescences 4–8, branched to 3 orders; prophyll 20–22 cm long, 3–4 cm wide, glabrous, apices papery, lacerate; peduncular bract single, infrequently lacking; rachis bracts sparsely tomentose; terminal partial inflorescence bifurcating at the base, ebracteate; rachillae 10–35 mm long, glabrous. *Flowers* solitary or in clusters of 2–4, broadly funnel shaped, 1.2–3 mm long, to *c.* 1 mm wide in bud; sepals triangular to broadly ovate, 1.2–3 mm long, acute to cuspidate, apex curved inward, white-cream; stamens *c.* 1.6 mm long; anthers *c.* 0.5 mm long, subglobose to ovoid, cream. *Fruit* ovoid-obovoid to infrequently pyriform, 8–14 mm long, 6–9 mm diam.; epicarp dull black-pruinose with scattered lenticellular pores; mesocarp thin, fibrous; endocarp thin, crustaceous. *Seed* ellipsoid, 7–9 mm long, 4–7 mm wide; eophyll long and narrow, 3-ribbed.

Diagnostic features. *Livistona leichhardtii* may be distinguished by the moderately tall stem; deeply divided leaves with pendulous segment apices; inflorescences with up to eight partial inflorescences; a single peduncular bract (infrequently lacking); and ovoid-obovoid, dull black-pruinose fruit.

Selected specimens. WESTERN AUSTRALIA: Kalumburu Mission, 1 Aug. 1973, *L. Brigden s.n.* (DNA); King Leopold Ra., Lenard River Gorge, *c.* 130 km ENE of Derby, 22 July 1974, *G.W. Carr* 3978 *& Beauglehole* 47756 (PERTH); King Leopold Ra., 26 km NE of Inglis Gap, 4 May 1996, *J.L. Dowe* 356–358 (BRI); El Questro Station, Cambridge Gulf, 100 m E of Pentecost River, 5 May 1996, *J.L. Dowe* 362 (BRI, FTG); Mt Broome, May 1905, *W.V. Fitzgerald s.n.* (PERTH); Mt Leake, July 1905, *W.V. Fitzgerald s.n.* (PERTH); Napier Bay, Lower King Edward River, 22 Aug. 1921, *C.A. Gardner* 1044 (PERTH); King Leopold Ra., 2 km W of March Fly Glen towards Derby on Gibb River road near Mt Bell, 20 Aug. 1983, *B. Hastings* 1 (PERTH); West Kimberley, 6.5 km NW of Kimbolton Homestead on mid Stewart River, 21 Aug. 1983, *B. Hastings* B2 (PERTH); King Leopold Ra., Sale River 29.2 km WSW of Mt French, 25 June 1987, *G.J. Keighery & J.J. Alford* 1402 (PERTH); Prince Regent River Reserve, Marigui Promontory, 27 Aug. 1974, *K.F. Kenneally* 2162

(PERTH); West Kimberley, gorge of unnamed creek running W of Sale River 30 km ESE of mountain, 15 May 1984, *K.F. Kenneally* 9652 (PERTH); Kimberley, 54.7 km SW of turnoff to Beverley Springs Homestead, Gibb River Road, 2 June 1986, *K.F. Kenneally* 9793 A (PERTH); West Kimberley, upper reaches of Roe River, 27 May 1987, *K.F. Kenneally* 9991 (PERTH); Chamberlain River Gorge, 7 km W of El Questro Station Homestead, 30 June 1989, *K.F. Kenneally* 10978 (PERTH); 19 km W of Cape Rulhiers, 4 June 1987, *K.F. Kenneally & B.P.M. Hyland* 10145 (PERTH); Sale River, 15.5 W of Mt Lochee, 19 June 1987, *K.F. Kenneally & B.P.M. Hyland* 10464 (PERTH); south base of Mt King, Durack Ra., *A.N. Rodd* 2868 (QRS); 3 km ESE of Kalumburu Mission, 25 Oct. 1974, *A. Rodd* 2871 (K); Mt Hart Station, 15 July 1997, *L. Wallis* LW(97A/82 (PERTH); south slopes of Sir Graham Moore Island facing the Geranium Islands, 3 Apr. 1991, *T. Willing* 293 (PERTH); Sir Graham Moore Island, 30 June 1973, *P.G. Wilson* 11222 (PERTH); Brunswick Bay, Uwins Island, 8 July 1973, *P.G. Wilson* 11450 (PERTH). NORTHERN TERRITORY: Trudies Falls, Spirit Hill Cons. area, 4 km NW of Nancys Gorge, 18 Aug. 1996, *I. Cowie* 7119, 7121 (DNA); Victoria River area, 9 Mar. 1989, *C. Dunlop* 8203 (DNA); Milligans Lagoon, Spirit Hill Station, Milligans Paddock, 26 June 1994, *D. Fett s.n.* (DNA); Keep River NP, *c.* 60 km NE of Ranger Station, 12 May 2011, *D. Lewis* 1705 (DNA); Trudies Falls, Spirit Hills Escarpment, 18 Aug. 1996, *C. Michell* 266 (DNA); Goobaieri Bay, Bradshaw Station, near Fire Plot 3, 18 Feb. 1999, *C. Michell* 2099 *& C. Yat*es (DNA); Spirit Hills Station, Kneebone area, 17 Sep. 1999, *D. Napier* 52 (DNA); Goobaieri Bay, Bradshaw Field Training Area, *c.* 90 km NW Timber Creek, 2 Apr. 2007, *B. Stuckey* 49 (DNA).

Distribution. Western Australia and Northern Territory. In the Northern Kimberley, Central Kimberley, Dampierland and Victoria Bonaparte bioregions, from Sir Graham Moore Island to Sale River, Cambridge Gulf, Macadam Range and Victoria River, and inland to the King Leopold and Durack Ranges.

Conservation status. *Livistona leichhardtii* is not considered under threat.

Etymology. Named for Friedrich Wilhelm Ludwig Leichhardt (1813–*c.* 1848), German-born explorer and naturalist, who vanished during an attempt in 1848 to traverse Australia from east to west. Ferdinand Mueller developed a life-long interest in Leichhardt, and promoted and organised several searches for the lost explorer and his party, but they were never found (Dowe & Maroske 2016).

Key to ovoid/obovoid-fruited species of *Livistona* in Australia

1. Petiole margins lacking spines, occasionally with small prickles toward the base; peduncular bracts lacking ..... **L. inermis**

1: Petiole margins with spines, longest toward the petiole base; peduncular bracts present **2**

2. Plants sexually dimorphic; inflorescences on male plants with 4–7 partial inflorescences and the female plants with a single terminal partial inflorescence; palms to 7 m tall ..... **L. humilis**

2: Plants not sexually dimorphic; palms to 21 m tall **3**

3. Leaves 9–20 in mature palm; leaf segments mostly rigid, free for *c.* 70% of the length of the leaf; leaf segment apical cleft *c.* 55% of the length of the segment; inflorescences branched to 3 orders; fruit glossy purple-black; palm to 21 m tall ..... **L. eastonii**

3: Leaves 25–40 in mature palm; leaf segments pendulous, free for *c.* 92% of the length of the leaf; leaf segment apical cleft *c.* 70% of the length of the segment; inflorescences branched to 4 orders; fruit dull pruinose-black; palm to 15 m tall ..... **L. leichhardtii**

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References

Beccari, O. (1921). Recensione delle palme del vecchio mondo appartenenti alla tribù delle Corypheae, con descrizione della specie e varietà nuove che vi appartengono. *Webbia* 5: 5–70.

Bentham, G. (1878). *Flora Australiensis*. Vol. 7. (L. Reeve and Co.: London.)

Brown, R. (1810). *Prodromus florae Novae Hollandiae et insulae Van-Diemen*. (Richard Taylor: London.)

Dowe, J.L. (2009). A taxonomic account of *Livistona* R.Br. (Arecaceae). *Gardens' Bulletin Singapore* 60(2): 185–344.

Dowe, J.L. (2010). *Australian palms: biogeography, ecology and systematics*. (CSIRO Publishing: Collingwood.)

Dowe, J.L. & Jones, D.L. (2011). Arecaceae. *In*: Wilson, A. (ed.) *Flora of Australia*. Vol. 39. pp. 145–210. (Australian Biological Resources Study: Canberra.)

Dowe, J.L. & Maroske, S. (2016). 'These Princely plants': Ferdinand Mueller and the naming of Australasian palms. *Historical Records of Australian Science* 27: 13–27.

Drude, O. (1893). Über die australischen *Livistona*-Arten. *Botanische Jahrbücher für Systematik Pflanzengeschichte und Pflanzengeographie* 39: 5–12.

Gregory, A.C. (1858). Journal of the North Australian Expedition, under the command of Augustus C. Gregory, Esq. (Gold Medalist R.G.S.); with report by Mr. Elsey on the health of the party. *Journal of the Royal Geographical Society* 28: 1–137.

Gregory, A.C. & Gregory, F.T. (1884). *Journals of Australian Exploration.* (James C. Beal: Brisbane.)

Martius, C.F.P. von (1838). *Livistona*. *Historia Naturalis Palmarum*, 1st edn, 3: 239–242.

Mueller, F. (1858a). An historical review of the explorations of Australia. *Transactions of the Philosophical Institute of Victoria* 2: 148–168.

Mueller, F. (1858b). Botanical report on the North-Australian Expedition, under the command of A.C. Gregory, Esq. *Journal of Proceedings of the Linnean Society. Botany* 2: 137–163.

Mueller, F. (1874a). Palmae. *Fragmenta Phytographiae Australiae* 8(68): 221–222.

Mueller, F. (1874b). Additamenta. *Fragmenta Phytographiae Australiae* 8: 279–284.

Mueller, F. (1878). Palmae. *Fragmenta Phytographiae Australiae* 11(89): 54–58.

Mueller, F. (1882). *Systematic census of Australian plants, with chronologic, literary and geographic annotations*. (M'Carron, Bird & Co.: Melbourne.)

Mueller, F. (1885). *Select extra-tropical plants, readily eligible for industrial culture or naturalisation, with indications of their native countries and some of their uses*. (John Ferres: Melbourne.)

Mueller, F. (1889). *Second systematic census of Australian plants, with chronologic, literary and geographic annotations*. (M'Carron, Bird & Co.: Melbourne.)

Mueller, F. (1892). The fan-palms of Australia (continued). *Gardeners' Chronicle*, third series, 11(282), 21 May: 652–653.

Rodd, A.N. (1998). Revision of *Livistona* (Arecaceae) in Australia. *Telopea* 8(1): 49–153.

Wendland, H. & Drude, O. (1875). *Palmae Australasicae*. *Linnaea* 39: 153–238.

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Making it official—formal description of two orange-flowered *Tephrosia* (Fabaceae: Millettieae) species from north-west Western Australia

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Abstract

Butcher, R. Making it official—formal description of two orange-flowered *Tephrosia* (Fabaceae: Millettieae) species from north-west Western Australia. *Nuytsia* 29: 251–267 (2018). Two long-standing manuscript names in *Tephrosia* Pers. are herein formalised as *T. densa* (Benth.) Pedley ex R.Butcher and *T. gardneri* Pedley ex R.Butcher, and their various informal names synonymised. Full descriptions and images are provided for both these north-west Western Australian species and their histories and affinities are discussed.

Introduction

Following Bentham's (1864) treatment of *Tephrosia* Pers. in Australia, in which 18 new taxa were described for Western Australia, taxonomic endeavours in this State progressed *ad hoc* over the following 62 years (Mueller 1879, 1880, 1883; Skan 1905; Domin 1912; Ewart & Morrison 1913; Fitzgerald 1918; Gardner 1923; Domin 1926) before Les Pedley commenced a more comprehensive investigation in the 1970s, laying the foundation for a further suite of regionally-focussed, revisionary publications (Pedley 1977; Maconochie 1980; Wheeler 1992; Cowie 2004; Butcher 2012; Butcher & Hurter 2012; Pedley 2014; Butcher *et al.* 2017; Butcher 2018).

The two *Tephrosia* species described herein were recognised as discrete by Pedley in 1984, through a series of herbarium specimen annotations. At that time they were given manuscript names, which were erected on the Western Australian vascular plant census and widely taken up by botanists in the State, before being converted to phrase names under Australian Plant Census (APC) protocols in 2012. To minimise taxonomic and nomenclatural confusion, the two long-standing manuscript names are retained, and herein formalised as *T. densa* (Benth.) Pedley ex R.Butcher and *T. gardneri* Pedley ex R.Butcher.

The two new species have some similarity in their shared possession of orange flowers, frequently prominent inflorescence and floral bracts, frequently rufous indumentum on the rachides of their elongate inflorescence and on calyces, as well as their turgid, linear pods, and mottled, transversely obloid seeds, which have a slightly to obviously excentric hilum, but they are readily distinguished by the shape of their leaflets.

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Methods

All *Tephrosia* specimens housed at PERTH were critically studied, as were all Western Australian specimens housed at AD, BRI, CANB, DNA, MEL, NSW and NT, and on loan from K. Types of all Australian species have been viewed on loan and through *Global Plants* (https://plants.jstor.org). Field work in the Carnarvon, Murchison and Pilbara bioregions was undertaken in 2011 and allowed for *in situ* examination of plants. Bioregions referred to in the text and displayed on distribution maps follow *Interim Biogeographic Regionalisation for Australia* (IBRA) v. 7 (Department of the Environment 2013).

Leaf venation terminology follows Ellis *et al.* (2009). The inflorescence is interpreted as a pseudoraceme following Tucker (1987, 2003), where the elongate rachis has fascicles of flowers in the axils of first-order bracts (here termed 'inflorescence bract'), each flower subtended by a second-order bract (here termed 'floral bract'); paired bracteoles on the pedicel can be present or absent. Fascicles comprise one or more 3-flowered units, with the first two flowers opening in relatively close succession and the third flower in each unit often delayed developmentally, with anthesis commonly occurring once the first two flowers have developed into fruits. As such a fascicle can potentially contain a mixture of fruits at different stages of maturity, flowers and buds; when flowers are present there are usually one or two open at a time.

Taxonomy

Tephrosia densa (Benth.) Pedley ex R.Butcher, *comb. et stat. nov.*

Tephrosia bidwillii Benth. var. *densa* Benth., *Fl. Austral.* 2: 210 (1864). *Type*: 'N. Australia. Hills near Nichol [Nikol] Bay [Western Australia], [*s. dat.*,] *F. Gregory's Expedition*.' (*holo*: K 000217093!).

Tephrosia densa (Benth.) Pedley ms, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 21 August 2018].

Tephrosia sp. Fortescue (A.A. Mitchell 606), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 21 August 2018].

Tephrosia sp. Meentheena (S. van Leeuwen 4479), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 21 August 2018].

Tephrosia sp. dense (A.C. Beauglehole 11456), *in sched.* [at DNA, NT].

Erect *subshrubs* to *shrubs*, few-stemmed, perennial, 0.2–1.4 m tall, 0.2–1.2 m wide. *Branchlets*, *leaf and inflorescence rachides* with a moderately dense to dense indumentum of short, straight, appressed to patent, white to stramineous to ferruginous hairs, 0.1–0.9 mm long. *Leaves* pinnate, 58–185 mm long including petiole; *stipules* persistent, antrorse, attenuate, 4.0–13.5 mm long, green drying stramineous, 1–3-nerved; *petiole* 6–30 mm long; *ultrajugal rachis* 0–8 mm long; *stipellae* absent; *petiolules* 0.9–3.5 mm long; *leaflets* (5–)7–17, narrowly lanceolate to narrowly elliptic, flat to V-shaped in T.S., at least some attached in the proximal half of the leaf; base cuneate; apex acute to rounded, straight or slightly deflexed; *lateral leaflets* 17–60 mm long, 2–10 mm wide, length 3.3–8.6(–10.4) × width; *terminal leaflet* 1–1.5 × the length of adjacent leaflets, 21–58 mm long, 3.0–10.1 mm wide, length (2.8–)4.2–9.3(–13.2) × width; lamina discolorous, greyish mid-green to glossy, dark green above, paler

grey-green below; upper surface glabrous or puberulous, hairs patent, fine, straight, hyaline, white; lower surface sparsely to densely pubescent, hairs appressed, straight, white or less commonly stramineous; secondary veins eucamptodromous, apically brochidodromous, in 7–15 pairs, intersecondary veins parallel to secondaries, which are often raised on the upper surface of the leaflets as well as the lower. *Inflorescence* pseudoracemose, leaf-opposed, 42–270 mm long, fascicles usually closely spaced, with 3–6 flowers in each cluster, 1 or 2 open at a time; *inflorescence bracts* antrorse, lanceolate, acuminate, 2.0–8.5 mm long, caducous; *floral bracts* lanceolate, 0.5–2 mm long, caducous; *bracteoles* absent; *pedicels* 1.3–5.8 mm long. *Calyx* 3.4–6.9 mm long, indumentum moderately dense to dense, usually ascending to patent, stramineous through ferruginous to dark chocolate brown, commonly mixed-coloured, rarely loosely appressed and white; tube 1.4–3.4 mm long, 0.6–1.2 × the length of lateral lobes; lower and lateral lobes narrowly deltoid to attenuate; vexillary lobes united higher than lower three, free for 0.4–1.5 mm length, upper lip divided to 20–60% length; lowest lobe 1.4–4.6 mm long, ±equal to laterals. *Corolla* orange, 8–12 mm long; *standard* (5.9–)6.2–9.2 mm long, (7–)8.1–11.2 mm wide, the claw 1.0–2.5 mm long, blade ovate to suborbicular, not or slightly callused at base, apex rounded to retuse; *wings* 6.4–9.5 mm long, 2.6–4.6 mm wide, ±equal to keel, the blade usually obovate, less commonly elliptic, with a rounded apex; *keel* 5.8–8.0 mm long, 2.6–3.7(–4.9) mm wide, the blade semi-circular, usually with hairs along the lower margin. *Staminal* tube usually glabrous or with short hairs present on margins of tube or on the sides near the tube apex, margins of fenestrae thickened to callused; vexillary filament straight, usually glabrous or with patent hairs in front of callosity or from middle of callosity to *c.* 2/3 filament length, callused near base; anthers 0.4–0.7(–0.8) mm long, 0.1–0.4(–0.6) mm wide. *Ovary* densely hairy; ovules (5–)6–10. *Style* flattened, tapering, glabrous; stigma penicillate, linear. *Pods* linear, straight with apex slightly upturned, 25–65 × 3.0–4.5 mm, turgid, stramineous at maturity, indumentum moderately dense to dense, appressed, inclined or patent, white, stramineous, ferruginous or brown, the hairs straight; beak in line with upper suture, straight to slightly inclined; white tissue present between seeds. *Seeds* 5–9 per pod, 4–6 mm between centres, transversely obloid-ellipsoid, 1.7–3.2 × 2.3–4.2 mm, finely mottled in combinations of olivaceous, light brown, brown, red-brown and black, the hilum encircled with green then orange, testa smooth or broadly dimpled, hilum excentric; rim-aril present, minute, annular, white. (Figure 1)

Diagnostic features. *Tephrosia densa* can be distinguished from all other species by the following combination of characters: pinnate leaves with (5–)7–17 narrowly lanceolate to narrowly elliptic leaflets 17–60 × 2–10 mm; persistent, antrorse, attenuate stipules; elongate pseudoracemes of orange flowers 8–12 mm long, with the calyx tube shorter than to *c.* same length as the lateral lobes, the hairs usually stramineous to brown and ascending to patent, and the stamens usually glabrous and callused near the base of the vexillary filament and on margins of fenestrae; (5–)6–10 ovules; turgid, linear pods with the apex slightly upturned and beak in line with upper suture and ±straight; transversely obloid-ellipsoid seeds 1.7–3.2 × 2.3–4.2 mm, with a finely mottled, ±smooth testa and excentric hilum.

Selected specimens examined. WESTERN AUSTRALIA: 13 km NNW of Mt Farquhar, pool of tributary of Serpentine Creek into Duck Creek at base of cliff, West Hamersley Ra., 25 July 1999, *B. Backhouse, D. Edinger & G. Marsh* BEM 105 (BRI, PERTH); Wittenoom Gorge, 18 Aug. 1963, *J.S. Beard* 2869 (PERTH); small granite range on N side of North West Coastal Hwy, *c.* 56 km SW of Nanutarra Roadhouse, 20 May 2011, *R. Butcher & S. Dillon* RB 1487 (DNA, PERTH, UWC); Meentheena Conservation Park; *c.* 57 km E along Ripon Hills Rd from Marble Bar, then 6.6 km S along track to Nullagine River camp, then walk *c.* 500 m W, 27 May 2011, *R. Butcher & S. Dillon* RB 1516 (PERTH, UWC); 14.6 km S of Nullagine on a tributary of Cajuput Creek, 11 Aug. 2007, *G. Byrne* 2831 (BRI, PERTH); Newman to Marble Bar road, 15 km S of Nullagine, 7 May 2006, *I.D. Cowie & R.A. Kerrigan* IDC 11129 (BRI, CANB, L, MEL, MO, NT, PERTH); 28.2 km S of Mt Minnie HS, 16.3 km SW of Mt Minnie, 31.8 km NNW of Mt Murray, 73.6 km SE of Onslow,

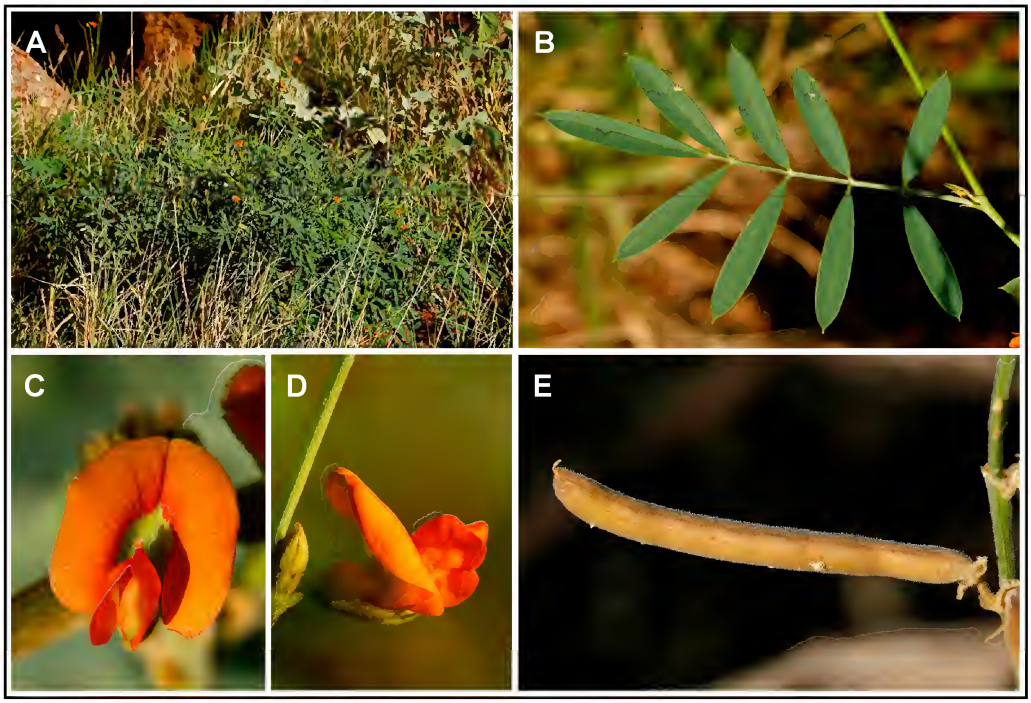

Figure 1. *Tephrosia densa*. A – spreading shrub habit; B – typical leaf, having a glabrous upper surface to oblanceolate leaflets; C – orange flower from front; D – orange flower from side, showing division and indumentum of the calyx; E – mature pod. Vouchers: *R. Butcher & S. Dillon* RB 1487 (A, B, D); RB 1490 (C, E). Photographer: R. Butcher.

Cane River Conservation Park, 23 June 2011, *S. Dillon & A. Markey* CR 9000 (AD, PERTH); Parry Ra., 7.7 km N of Mt Murray, 10.3 km NE of Nanutarra-Wittenoom Rd and North West Coastal Hwy intersection, 15 km NE Nanutarra Roadhouse, 100 km SE Onslow, Cane River Conservation Park, 27 June 2011, *S. Dillon & A. Markey* 9001 (DNA, PERTH); 142 mi. S of Port Hedland, on Wittenoom road, 26 Aug. 1960, *A.S. George* 1074 (PERTH); Barlee Range Nature Reserve, Kookhabinna Gorge below Currung-Kohndunna Pool, 24 km SSE of Mt Florry, 13 Sep. 1995, *S. van Leeuwen* 2292 (DNA, PERTH); Uaroo Stn, 21.8 km N of Towera Stn t/o on North West Coastal Hwy, 24 km SW of Globe Hill, 22.7 km SSW of Cheetara Rock, 16.2 km ENE of Old Barradale, 6 July 2002, *S. van Leeuwen* 5035 (BRI, DNA, PERTH); site: PHYE09, 10.3 km SW of Warrawagine Stn HS, 41.5 km WSW of Mt Cecelia, 95.8 km ENE of Marble Bar, 20 Aug. 2006, *S. van Leeuwen et al.* PBS 0244 (BRI, PERTH); site: TCMBE12, 10.1 km NE of Mt Nameless, 23.6 km W of Mt Hyogo, 7.8 km NE of Tom Price, 4 June 2006, *S. van Leeuwen et al.* PBS 0250 (DNA, PERTH); site: TCMBW01, 5.6 km W of t/o to Rocklea Stn HS on Munjina - Nanutarra Rd, 14.7 km SSW of Mt Turner, 43.8 km WSW of Tom Price, 6 June 2006, *S. van Leeuwen et al.* PBS 0254 (K, NT, PERTH); Rudall River region, June 1987, *W.G. Martinick & Associates s.n.* (PERTH); 5 km NW of Woodstock HS, 15 Aug. 1988, *A.A. Mitchell* 1668 (CANB, DNA, K, PERTH); 7 km NE of Quarry Hill, *c.* 120 km W of Tom Price, 1 Aug. 1984, *K.R. Newbey* 10670 (CANB, MEL, PERTH); Coolthara Pool, Ullawarra Stn, 16 Aug. 1961, *R.D. Royce* 6490 (CANB, PERTH); Marandoo Ridge, Hamersley Ra., 20 June 1975, *M.E. Trudgen* 1306 (K, MEL, PERTH); 8.4 km E of Coppin Pool on track to Juna Downs Stn, Hamersley Range National Park, 9 May 1980, *M.E. Trudgen* 2484 (AD, DNA, PERTH); site no. 901, 3 km NNE of West Angela Hill, Hamersley Ra., 5 July 1997, *M.E. Trudgen* MET 16119 (MEL, PERTH); site no. 967, 3.75 km WNW of Packsaddle Hill, Hamersley Ra., 12 July 1997, *M.E. Trudgen* MET 16150 (BRI, CANB, DNA, MEL, PERTH); site no. 1008, 8.5 km SSW of West Angela Hill, Hamersley Ra., 15 July 1997, *M.E. Trudgen* MET 16176 (MEL, PERTH).

Phenology. Flowers observed March to August, with fruits and seeds collected May to September.

Distribution. Widespread across the Pilbara and north-west Gascoyne bioregions of Western Australia, with limited collections from adjacent areas of the Carnarvon, Little Sandy Desert and Great Sandy Desert bioregions. Occurs in the area roughly bounded by Mt Augustus to the south, Giralia Station to the west, Karratha (and islands) to the north, and the Rudall River area to the east (Figure 2A).

An outlying specimen at PERTH (*J. Morrissey* 52; PERTH 02923882) is labelled as being from 'Wiluna area', which, if correct, places it over 350 km south of the geographically nearest collections around Newman. Despite them having different collection dates and locality statements on their labels, it is highly probable that this specimen is duplicate material of a specimen collected from '14 miles N Mt Phillipe [Phillips]' (*J.G.M. [J.G. Morrissey]* 52; PERTH 08003025), which is *c.* 30 km west of Mt Augustus. Not only do the fragments on each sheet have identical morphology, but the same discrepant pattern has been uncovered in other duplicated *Morrissey* numbers across a range of taxa. For example, for his following numbers (7, 8, 11, 14, 17, 19, 23, 24, 29, 31, 34, 42, 43, 58, 65) there are a pair of sheets at PERTH, one having the collection date 'Dec. 1970' and the locality 'Wiluna area', the other having the collection date '1971' or '1972' and a specific (and different) locality statement for each taxon; these latter sheets were transferred back to PERTH in 2008 from the Meekatharra District Office, Department of Agriculture and Food (MEEK.) following its closure in 2006. Morrissey was a rangeland researcher with the Agriculture Department and periodically sent specimens to PERTH for identification; these were retained, with a list of plant names being returned to MEEK. (J. Morrissey, pers. comm.). In the discrepant duplicates above, the original collections likely remained at MEEK. with excess material being sent to PERTH for identification; Morrissey (pers. comm.) believes that the collection information on the MEEK. specimens is accurate, therefore it is likely that the collection data on the other sheets was corrupted at some stage during specimen transfer and processing in the early 1970s. As such, the collection location near Mt Phillips for *Morrissey* 52 (PERTH 08003025, ex MEEK.) is viewed as correct, while 'Wiluna area' (which maps to Wiluna on AVH etc.) is viewed as an incorrect locality for the species.

Habitat. *Tephrosia densa* grows in a range of habitats, in red-brown gritty to stony clay loams, sandy loams and loams, usually in association with rocks (granite boulders, quartz hills, basalt rockpiles, silcrete/limestone, gully slopes). One collection is from a low coastal dune in pale brown coarse sand (*D.J. Edinger* 5978 C; Giralia Station); the specimen has very slender leaflets (L:W = 10–21; not included in taxon description) and is in bud only, but appears to be this taxon. Grows in open tall shrubland or open low *Acacia* woodland with low shrubs and tussock grassland, or *Triodia* hummock grassland with scattered *Corymbia* or *Eucalyptus*.

Conservation status. This species is widespread and is currently not considered to be under threat; it does not have a conservation listing in Western Australia.

Etymology. The epithet was raised as a manuscript name by Les Pedley and is an elevation of Bentham's (1864) varietal name. The taxon was recognised as distinct from typical *T. bidwillii* Benth. by its 'Leaflets shorter and more silky; inflorescence dense, but with the calyx of *T. [b]idwillii*' (Bentham 1864: 210). As noted, the inflorescences on the type are denser than those on *T. bidwillii* specimens; however, they are clearly not yet fully elongated. Despite this, the epithet is retained for nomenclatural stability.

Affinities. *Tephrosia densa* is similar to collections of *T.* sp. B Kimberley Flora (C.A. Gardner 7300) that have broader leaflets (mostly Kimberley and NT specimens), but that taxon can be distinguished

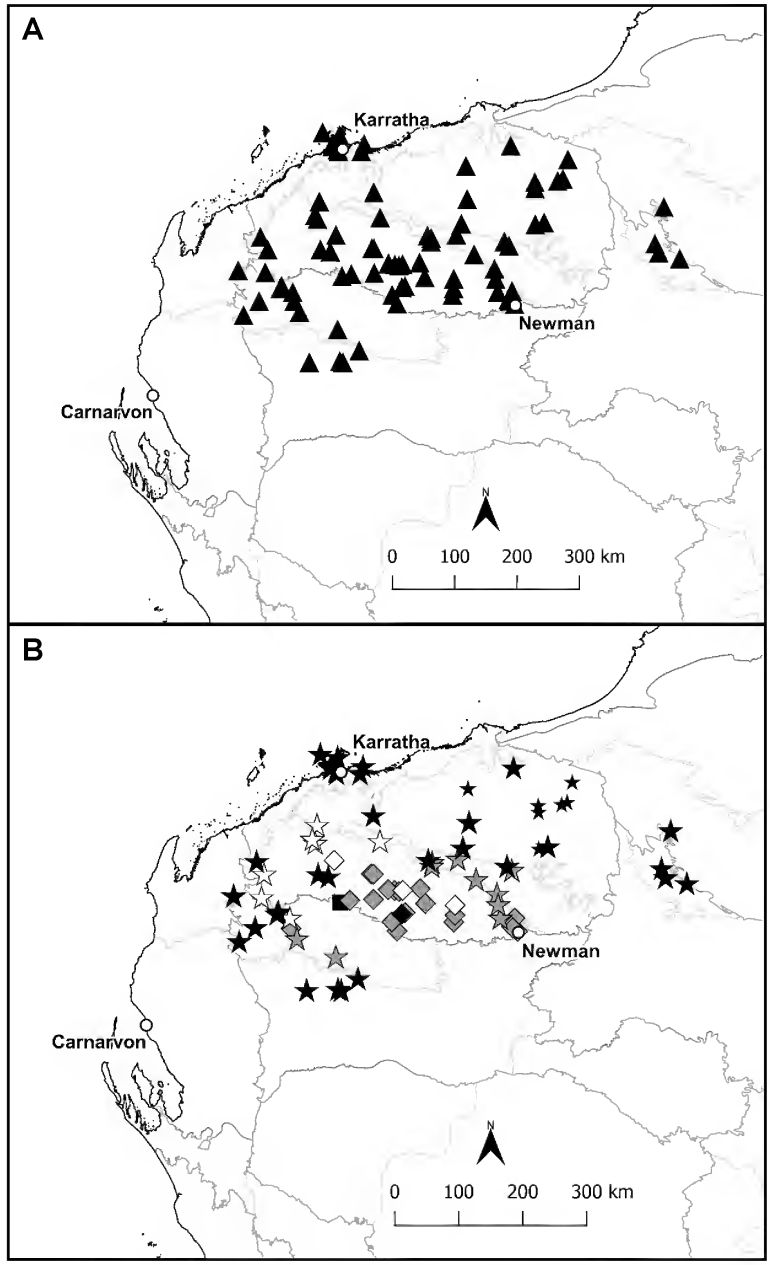

Figure 2. Distribution of *Tephrosia densa* in Western Australia, based on PERTH specimen data. A – all records of *T. densa* (black triangles); B – all records of *T. densa* by form and the indumentum of their upper leaflet surface and pods: formerly *T.* sp. Meentheena and *T.* sp. Fortescue/'*T. bidwillii*' identical to these with glabrous upper/appressed pods (small black stars), *T.* sp. Fortescue with glabrous upper/appressed pods (black stars), glabrous upper/inclined–patent pods (grey stars), glabrous upper/pilulose elsewhere/long-patent pods (white stars), patent upper/pilulose elsewhere/long-patent pods (white diamonds), patent upper/patent pods (grey diamonds), patent upper/appressed pods (black diamond), appressed upper/appressed pods (black square). *Interim Biogeographic Regionalisation for Australia* v. 7 (Department of the Environment 2013) bioregions are shown in grey, with subregions in light grey.

by its early deciduous stipules, sparsely appressed-sericeous indumentum on calyces and fruits, the calyx tube being more strongly curved on the adaxial surface, the standard petal having prominent, elongate callosities at the base, and the vexillary filament thickening in all directions from the base and having rounded protuberances on the upper and lower surfaces. Investigation of the status of *T. bidwillii* in Western Australia found that while there was superficial similarity between the two taxa, *T. densa* was a clearly different species (*cf.* a variety of the Queensland-New South Wales endemic *T. bidwillii*); the similarities and differences between them are discussed in Butcher (2012).

Notes. Although this taxon had a validly published varietal name (*T. bidwillii* var. *densa*), the decision to recognise the manuscript name *T. densa* (Benth.) Pedley ms as a phrase name at species rank (i.e. *T.* sp. Fortescue) for the APC recognised Pedley's prior taxonomic conclusion that it was a species distinct from *T. bidwillii*.

The type specimen of *T. bidwillii* var. *densa* comprises two small pieces, evidently taken from the upper part of the plant, with leaves, flowers and just-initiated fruits. The specimen is densely-flowered and has stramineous, appressed indumentum on the inflorescence rachis, and rufous, strongly inclined to patent hairs on the bracts and calyces; the leaves have 11–17 narrow leaflets, which are appressed-hairy below and glabrous on the upper surface, with prominent, raised secondary veins. A specimen held at PERTH that is a good match for the type (when the upper portions of the branches are considered) is *B.R. Maslin* 4707, collected from near Roebourne, *c.* 20 km from Nikol Bay.

The name *T.* sp. Meentheena (S. van Leeuwen 4479) was erected on the Western Australian vascular plant census in July 2003 following survey of Meentheena Conservation Park by (the then) Department of Conservation and Land Management staff and volunteers as part of a Landscope Expedition in May 2000. A duplicate of the specimen was sent to *Tephrosia* specialist Ian Cowie (DNA) for identification in February 2002; his response in November 2002 was '4479 *T.* sp. – I need to look into this more – new.' At this stage Cowie's revisionary work on the Western Australian taxa was in its infancy and, combined with the rather poor quality specimen (stems with few leaves with many leaflets missing, no mature flowers, fruits insect damaged) and the leaflets being narrow and widely spaced, it is easy to see why this was not identified as '*T. densa*' at the time. In addition to the handful of *T.* sp. Meentheena specimens at PERTH were a small number with identical morphology (i.e. having slender, widely-spaced leaflets that were glabrous on the upper surface and sparsely to moderately hairy below, long inflorescences, and paler indumentum) that were identified as either *T.* sp. Fortescue, or as *T. bidwillii*; they are all now included in *T. densa*.

Preliminary sorting of specimens identified two broad groups where the indumentum of the upper surface of the leaflet was correlated with the indumentum on the pods, suggesting that there may have been more than one taxon. Specimens in the first group had a glabrous upper leaflet surface and appressed hairs on the pods, while those in the second had short, hyaline or white, patent hairs on the upper leaflet surface and patent hairs on the pods. While the majority of specimens fall into one of these two groups, with a glabrous upper leaflet surface being most common, a smaller number of specimens with intermediate and novel combinations of indumentum characters were identified, as was additional variation in the density, length and orientation of hairs among specimens within each group. This variation is summarised in Table 1. There is a tendency for narrower leaflets to be glabrous on the upper surface and for broader leaflets to be patently hairy, but this is not consistent; leaflets with a range of widths and lengths can be found in both of these broad indumentum groups. Variation in the indumentum of the upper leaflet surface is also observable in the Pilbara taxa *T.* sp. NW Eremaean (S. van Leeuwen et al. PBS 0356), *T.* sp. clay soils (S. van Leeuwen et al. PBS 0273) and *T. clementii* Skan.

Table 1. Indumentum variation on upper and lower surfaces of leaflets, and pods, in *Tephrosia densa*, indicating representative specimens; a selection only (e.g.) is given for the two most common forms. * = typical form.

Leaflet upper surface	**Leaflet lower surface**	**Pod**	**Representative specimens (PERTH sheets viewed)**
glabrous	appressed, very sparse	appressed	*R. Butcher & S. Dillon* 1487 *R.J. Cranfield* 1786 *S. Dillon & A. Markey* CR 9000 *S.D. Hopper* 5037 *S. van Leeuwen* 1478 *S. van Leeuwen* 2205 *S. van Leeuwen* 5035 *L. Sweedman* 8315
glabrous	appressed	appressed	*e.g. *R. Butcher & S. Dillon* RB 1517 *K. Glennon* 409K *S. van Leeuwen et al.* PBS 0243 *Martinick & Associates s.n.* (June 1987) *K. Newbey* 10670 *M.E. Trudgen* MET 15512 *E. Wittwer* 1064
glabrous	appressed	inclined–sub-patent	*J.V. Blockley* 198 *T.R. Lally* TRL 725 *R.D. Royce* 6490 *C. Sgherza* 76 *E. Wittwer* S.1793
glabrous	appressed	patent	*J.S. Beard* 2869 *A.C. Beauglehole* 11456 *D.J. Edinger* 5132 *T. Edwards* MN 01.10 *A.S. George* 1074 *E. Mattiske* 34
glabrous	inclined–patent, pilulose–pilose	moderately long, inclined–patent	*S. Dillon & A. Markey* CR 9001 *M. Hay & S. Yandle* M 088 *S. van Leeuwen et al.* PBS 0252 *S. van Leeuwen* 2292 *A.A. Mitchell* PRP 1526 *B. Morgan & R. Warner* BES RW 014 *M.E. Trudgen & R. Parnell* MET 11626
patent to appressed	appressed	appressed	*J. Atkinson* JA 038 *A.A. Mitchell* 76/90

Leaflet upper surface	Leaflet lower surface	Pod	Representative specimens (PERTH sheets viewed)
patent	appressed–loosely appressed	patent	e.g. *B. Backhouse, D. Edinger & G. Marsh* BEM 184 *S. van Leeuwen et al.* PBS 0250 *S. van Leeuwen et al.* PBS 0253 *N. Walsh* 6473, *D. Halford & D. Mallinson* *F. Obbens* FO 11/06 *C. Sgherza* 77 *J. Young* 73
patent	inclined–patent	moderately long, patent	*B. Backhouse, D. Edinger & G. Marsh* BEM 105 *S. van Leeuwen et al.* PBS 0251 *M.E. Trudgen* MET 16150

Some of the morphological variation observed is correlated with geographic distribution. Specimens with a glabrous upper leaflet surface have the widest distribution (Figure 2B, stars) and can be found from the Gascoyne (Ashburton & Augustus subregions) to the Little Sandy Desert (Rudall subregion) bioregions and across the Pilbara (Roebourne, Chichester, Fortescue & Hamersley subregions), with narrow-leafleted specimens previously identified as *T.* sp. Meentheena (or *T. bidwillii*) occurring in the east and north-east of the range of *T. densa* (Marble Bar through Nullagine to Telfer; Figure 2B, small stars). Specimens with glabrous upper leaflet surfaces and longer hairs elsewhere have been collected from the western part of the Hamersley Range (Figure 2B, white stars) from sites frequently recorded as being gentle lower slopes, or in drainage lines. Interestingly, specimens with patent indumentum on the upper surface of the leaflet are nearly restricted to the Hamersley subregion, in the central part of the species' range (Figure 2B, diamonds). Also notable is that specimens having patent or pilulose indumentum on the pods, regardless of the indumentum on the leaflets, are again most frequent in the Hamersley subregion and adjacent areas (Figure 2B, white and grey stars and diamonds).

Additional variation across *T. densa* includes: number and density of the leaflets on the leaf rachis; leaflet length and width; prominence of the veins; length of the inflorescence; spacing of the flower fascicles; colour of the indumentum on rachides, calyces and bracts; presence or absence of hairs on the stamens; pod length. The presence of hairs on the stamens was variable in presentation (three specimens had hairs on the staminal tube only, one had hairs on the vexillary filament only, while seven had hairs on both; Table 2) and in most cases was not correlated with a higher density, or length, of hairs elsewhere on the specimen. Detailed study of specimens at PERTH has not identified any patterns of correlation between these characters that supports there being more than one taxon in *T. densa*.

Tephrosia gardneri Pedley ex R.Butcher, *sp. nov.*

Type: 3 km west of North West Coastal Highway on road to New Beach, *c.* 10 m south of road, south of Carnarvon, Western Australia, 7 September 2011, *R. Butcher & R. Davis* RB 1543 (*holo*: PERTH 08293015; *iso*: CANB, K, MEL).

Tephrosia gardneri Pedley ms, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 21 August 2018].

Tephrosia sp. Carnarvon (J.H. Ross 2681), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 21 August 2018].

Tephrosia sp. Onslow (K.R. Newbey 10571), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 21 August 2018].

Tephrosia morrisonii Pedley ms, *in sched.* [at PERTH]

Tephrosia 'ovaria', in sched. [at BRI]

Ascending to erect, *subshrub* or *shrub*, single-stemmed just at base then widely branching, short- to long-lived perennial, 0.5–1.75 m tall, to 2 m wide. *Branchlets*, *leaf and inflorescence rachides* with moderately dense to dense (rarely sparse) indumentum of short, straight, ascending to patent, hyaline and white to stramineous to ferruginous or dark brown hairs, 0.05–0.6 mm long. *Leaves* pinnate, 60–230 mm long including petiole; *stipules* persistent or tardily caducous, antrorse becoming patent and reflexed with age, triangular to long-attenuate, 2.7–6.7 mm long, green to tan, 1–5-ribbed; *petiole* 12.0–54.5 mm long; *ultrajugal rachis* (1.5–)4–22.0 mm long; *stipellae* absent; *petiolules* 0.6–4.5 mm long; *leaflets* (3–)5–13, ovate through elliptic (incl. ±rhomboid) to obovate and narrowly obovate, flat in T.S., at least some attached in proximal half of leaf; base cuneate; apex rounded, frequently retuse, usually straight, minutely mucronate with mucro 0–0.8 mm long; *lateral leaflets* 9–49 mm long, 4–34 mm wide, length 1.0–3.1(–4.4) × width; *terminal leaflet* 0.7–1.8 × the length of adjacent laterals, 11.5–53.0 mm long, 5.0–39.5 mm wide, length 1.2–2.9(–3.4) × width; lamina discolorous, very pale to lime green above, light to mid-green below; upper surface sparsely to densely hairy, the hairs appressed to ascending, sometimes patent, straight, hyaline, silvery or white; lower surface moderately to densely hairy, the hairs appressed to ascending, sometimes patent, straight, hyaline, white to silvery, stramineous to brown on veins; secondary veins brochidodromous, but appearing craspedodromous to semireticulodromous in thinner-textured leaflets, in 7–16 pairs, intersecondary veins apparently reticulate, usually obscured by indumentum on lower leaflet surface, but raised on thicker-textured leaflets. *Inflorescence* pseudoracemose, leaf-opposed in a terminal position, 50–300(–400) mm long, fascicles moderately to closely spaced, 3–6-flowered; *inflorescence bracts* triangular to lanceolate, acute to acuminate, 2.0–6.7 mm long, caducous; *floral bracts* attenuate to filiform, 1.5–4.0 mm long, caducous; *bracteoles* absent; *pedicels* 2.0–6.5 mm long. *Calyx* 3.2–8.0 mm long, indumentum dense, the hairs patent to inclined, brown to ferruginous, occasionally white or stramineous; tube 1.5–3.5 mm long, 0.4–0.75 × the length of lateral lobes; lower and lateral lobes attenuate; vexillary lobes united higher than lower three, free for 1–2 mm, upper lip divided to (28–)46–83% length; lowest lobe 2.6–4.8 mm long, ±equal to lateral lobes. *Corolla* orange to orange-red, 7–15 mm long; *standard* (6.3–)7.0–12.5 mm long, (7.1–)9.0–15.2 mm wide, the claw 1.2–2.5 mm long, the blade ovate to sub-orbicular, not or slightly callused at base, apex retuse; *wings* (6.3–)8.5–14.0 mm long, (3.2–)4.1–8.4(–10.3) mm wide, shortly to greatly exceeding keel, the blade usually elliptic to ovate with an obtusely rounded apex; *keel* (5.2–)5.9–9.0 mm long, (2.2–)3.3–5.6(–7.9) mm wide, the blade usually semi-circular, glabrous or with very sparse short hairs along the lower margin. *Staminal* tube hairy near fenestrae with hairs concentrated on marginal callosities towards the base; vexillary filament straight in lower half, patently hairy on callosities near base; anthers 0.4–0.8 mm long, 0.1–0.5 mm wide. *Ovary* densely hairy; ovules (6–)8–12. *Style* flattened, tapering to apex, hairy at base just above ovary to (rarely) nearly 1/3 style length; stigma with short to moderately long hairs at base, linear. *Pods* linear, curved upwards just at apex, 41–52 × 3.5–5(–6) mm, turgid, stramineous to olivaceous at maturity; indumentum dense, patent, white, stramineous, ferruginous or brown; beak in line with the upper suture, straight to upcurved; white tissue present between seeds. *Seeds* (2–)6–12 per pod, (3–)3.5–5.0 mm between centres, transversely obloid, 1.9–3.2 × (1.8–)2.3–5.0 mm, finely to boldly

mottled in orange, brown, pale yellow and green, testa smooth, hilum excentric; rim-aril present, small, annular, white. (Figure 3)

Diagnostic features. *Tephrosia gardneri* can be recognised by the following combination of characters: leaves with (3–)5–13, flat, ovate through elliptic (incl. ±rhomboid) to obovate and narrowly obovate leaflets; calyx usually with patent, dark indumentum; long pseudoracemes of deep orange flowers with caducous inflorescence and floral bracts, prominent, hairy callosities on the staminal tube and vexillary filament, and (6–)8–12 ovules; long, slender, linear, turgid fruits that are upturned just before the apices with the beak in line with the upper suture and straight to upcurved; transversely obloid seeds that are variously mottled in orange, brown, pale yellow and green, and have an excentric hilum with a small, white, annular rim-aril.

Selected specimens examined. WESTERN AUSTRALIA: Northern form - Astron ESSC4-10, 12 km SW of Onslow, 29 Aug. 2009, *J. Alford* JJA 2009/02 (PERTH); Carnarvon, *s. dat.*, *G.B. Barnett s.n.* (PERTH, 2 sheets); North West Coastal Hwy, 18.5 km SSW of Onslow Rd, 11 Sep. 2011, *R. Butcher & R. Davis* RB 1559 (DNA, PERTH); dunes behind Onslow jetty, *c.* 50 m SW along track to 4 Mile Beach from Sunset Beach recreation area (along Simpson St), Onslow, 11 Sep. 2011, *R. Butcher & R. Davis* RB 1562 (BRI, MEL, PERTH); Tent Island Nature Reserve, 29 July 2015, *N. Godfrey* NG 149/15 (PERTH); site: WYW04, 34.2 km N of Mt Murray, 34.7 km WNW of Mt Amy, 39.8 km N of Nanutarra Roadhouse, Cane River Conservation Park, 4 Aug. 2004, *S. van Leeuwen et al.* PBS 0293 (AD, NSW, PERTH); *loc. cit.*, 11 Aug. 2005, *S. van Leeuwen et al.* PBS 0294 (CANB, PERTH); 4 km SW of Onslow, 28 July 1984, *K.R. Newbey* 10571 (BRI, CANB, DNA, PERTH); school Onslow, 6 July 1977, *S.P. Pfeiffer* 34 (PERTH); North West Coastal Hwy, 7.8 km S of the Onslow t/o, 12 July 2012, *K.R. Thiele* 4606 (PERTH); Southern form - 5.9 km W along Uendoo Creek Rd from North West Coastal Hwy, S side of road, S of Carnarvon, 8 Sep. 2011, *R. Butcher & R. Davis* RB 1547 (DNA, PERTH); Mardathuna Stn HS, dune behind old Mrs B's cottage, W of Kennedy Ra., SE of Carnarvon, 8 Sep. 2011, *R. Butcher & R. Davis* RB 1549 (DNA, PERTH); 42.2 km S of Minilya on North West Coastal Hwy, N of Boologooro Stn, E side of road, *c.* 92 km N of Carnarvon, 12 Sep. 2011, *R. Butcher & R. Davis* RB 1566 (BRI, MEL, NSW, PERTH, UWC); sand dunes, Carnarvon, 14 Aug. 1932, *C.A. Gardner* 3015 (PERTH, 2 sheets); Gascoyne Junction, Aug. 1984, *G. Gintzburger* 840814/5 (PERTH); 7.5 km S of Carnarvon on N[orth] W[est] Coastal Hwy, 19 Aug. 1986, *N.S. Lander* 1354 (CANB, MEL, PERTH); S of [Vlaming Head] Lighthouse, S[e]ismic track, 1 km N of area B boundary, Aug. 1978, *G. Perry* 862 (PERTH); Mangrove Point, Carnarvon, 29 Aug. 1982, *J.H. Ross* 2681 (AD, BRI, CANB, MEL, PERTH); Bibawarra Rd 1.9 km S of Blowholes Rd, *c.* 16 km direct line NNE of Carnarvon, 13 July 2012, *K.R. Thiele* 4611 (PERTH); North West Coastal Hwy, 10.3 km S of Carnarvon-Geraldton intersection, 16 July 2005, *J.E. Wajon* 1366 (PERTH).

Phenology. Flowering June to November with fruiting commencing from July; mature fruits with seed observed from August to November.

Distribution. Occurs in the Carnarvon, Gascoyne, Murchison and Pilbara bioregions of Western Australia in the area roughly bounded by Onslow in the north, inland towards Mileura Homestead in the south-east, and north-westward to Hamelin Pool, Shark Bay (Figure 4A). Also found offshore, with one collection from Tent Island, in the Pilbara bioregion.

Habitat. Grows in coastal and near-coastal dune habitats in pink-brown to red-brown sand, often adjacent to saline flats, extending inland to consolidated dunefields and Aeolian sandplains in pastoral country. Commonly occurs in tall, open *Acacia* spp. shrubland with *Crotalaria cunninghamii*, *Grevillea*

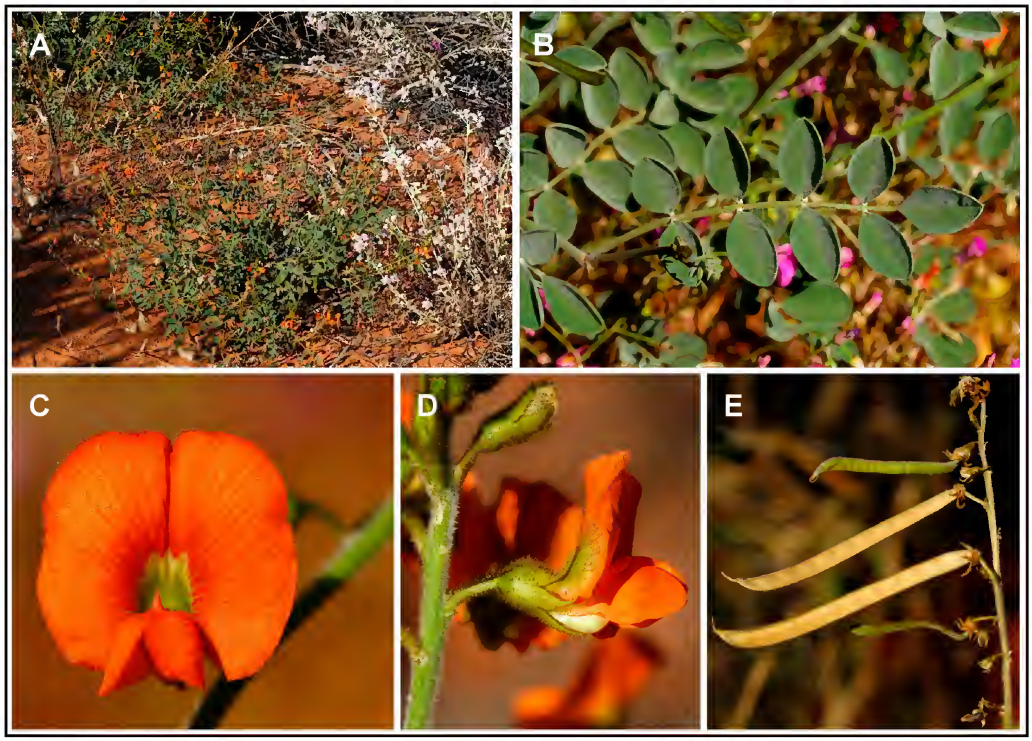

Figure 3. *Tephrosia gardneri*. A – spreading, low shrub habit, in near-coastal sand dune habitat; B – typical leaf, with ovate to elliptic leaflets; C – orange flower from front, D – orange flower from side, showing division and indumentum of the calyx; E – mature pods. Vouchers: *R. Butcher & R. Davis* RB 1544 (A, D); RB 1547 (B, C); RB 1566 (E). Photographer: R. Butcher.

stenobotrya and *Verticordia forrestii* over open *Triodia* spp. hummock grassland, on dunes and plains, with near-coastal vegetation comprising open *Acacia* spp. shrubland with mixed low shrubs and herbs.

Conservation status. This species is widespread and is currently not considered to be under threat; it does not have a conservation listing in Western Australia.

Etymology. The epithet was raised as a manuscript name by Les Pedley to honour botanist Charles Austin Gardner (1896–1970), former Curator of the Western Australian Herbarium (1929–1960), and the earliest collector of this species (in 1932) as indicated by PERTH specimens.

Affinities. In foliage morphology and flower colour, *T. gardneri* is similar to the Kimberley species *T. coriacea* Benth. and *T. flammea* Benth., and it is from the latter that Pedley first segregated mis-identified specimens of this taxon. *Tephrosia coriacea* has similarly shaped leaflets, but is readily distinguished from *T. gardneri* by its slender, erect habit, axillary clusters of flowers, and shortly petiolate, usually unifoliolate (sometimes trifoliolate) leaves, which are often held in a strongly ascending position, as well as its shorter, broader fruits with four to six seeds. *Tephrosia flammea* bears its flowers in elongate pseudoracemes, but is a taller shrub with a silvery to golden hue and has leaves with early caducous stipules and one to nine, larger, ovate to elliptic-oblong leaflets with prominent, reticulating intersecondary venation; both species have linear pods and seeds with an excentric hilum, but those of *T. flammea* have the hilum surrounded by an enlarged aril. Neither *T. coriacea* nor *T. flammea* have the patent, rufous to dark brown indumentum on inflorescence rachides and calyces that is commonly seen in *T. gardneri*.

Table 2. Specimens of *Tephrosia densa* studied that have hairs on the staminal tube or vexillary filament, indicating variable placement of hairs.

Specimen	Staminal tube with hairs on sides	Staminal tube fenestrae with hairs on margins	Vexillary filament patently hairy in front of callosity	Vexillary filament hairy from middle of callosity to 2/3 length
J.S. Beard 2869		+		+
A.C. Beauglehole 11456				+
G. Byrne 128		+		+
E.M. Goble-Garratt 98	+			+
S. Hopper 5037	+	+	+	
B.R. Maslin 4707		+		
A.A. Mitchell PRP 1299	+	+		+
K. Newbey 10670		+		
M.E. Trudgen 16176	+			+
J. Tyler & K. Gillen 291	+			
P.G. Wilson 10562		+		+

Notes. In December 1984, L. Pedley put determinavit slips on a number of PERTH specimens, marking some as *T. gardneri sp. nov.* and a smaller number as *T. morrisonii sp. nov.* In subsequent years all these specimens were amalgamated at PERTH under *T. gardneri* Pedley ms; the name was never published, later becoming *T.* sp. Carnarvon (J.H. Ross 2681) under APC naming protocols. Later study of the specimens bearing Pedley's 1984 determinavits (by the author and Ian Cowie) identified some subtle characters that appeared to distinguish his (*in sched.*) names. The name *T.* sp. Onslow (K.R. Newbey 10571) was then erected on the vascular plant census to account for those specimens matching Pedley's *T. morrisonii*, with the following text: 'Very closely allied to *T. gardneri* Pedley ms but differing in its shorter, denser stem indumentum; shorter, early-deciduous floral bracts; and caducous stipules. May represent a subspecific taxon with further research.' (R. Butcher *in sched.*).

Although two forms are more or less recognisable, detailed study of specimens placed in *T.* sp. Carnarvon and *T.* sp. Onslow, and targeted fieldwork, has since failed to find a consistent suite of characters by which these two putative taxa can be distinguished. There are certainly trends in morphology that are correlated with geographic distribution (e.g. southern collections frequently have longer, less-dense, darker indumentum on stems; smaller, more-numerous, finer-textured leaflets with a higher L:W ratio (1.2–3.1(–4.4)), the secondary venation scarcely raised and the intersecondary venation obscure; green, reflexed stipules; longer inflorescence and floral bracts; higher number (8–12) of ovules. Northern collections commonly have shorter, denser, paler indumentum on stems; larger, fewer, thicker, more-densely hairy leaflets with a lower L:W ratio (1–1.9(–2.3)), the secondary venation raised on both surfaces and often divaricating well-before the margin, and the intersecondary venation indistinctly reticulate; yellow-tan, spreading stipules that often fall; shorter inflorescence and floral bracts; fewer (6–10) ovules) and with habitat (e.g. plants from consolidated dunes tend to be taller, open, woody shrubs, with prominent leaflet venation and smaller flowers, while plants from near-coastal dunes and Aeolian plains are smaller and more lush, with longer inflorescences and larger flowers); however, there are also intermediate specimens (e.g. *J. Alford* JJA 2009/02, *J.S. Beard* 3623, *H. Demarz* 2490,

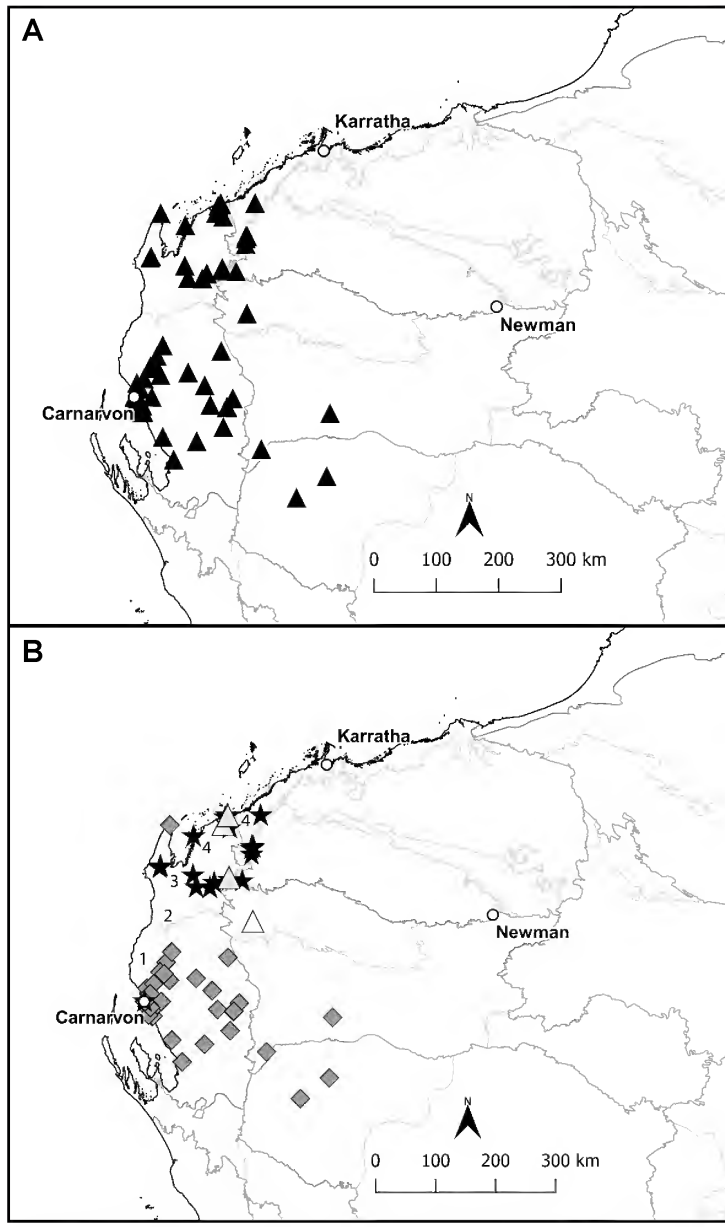

Figure 4. Distribution of *Tephrosia gardneri* in Western Australia, based on PERTH specimen data. A – all records of *T. gardneri* (black triangles); B – all records of *T. gardneri* by their *T.* sp. Carnarvon (grey diamonds) and *T.* sp. Onslow (black stars) morphological groupings, with intermediates also shown (white triangles); areas of unsuitable habitat contributing to disjunctions include Lake MacLeod and fringing samphire flats (1), Giralia Range (2), Rough Range (3), and extensive tidal flats (4). *Interim Biogeographic Regionalisation for Australia* v. 7 (Department of the Environment 2013) bioregions are shown in grey with subregions in light grey.

A. Morrison s.n. PERTH 02925354) that bring together the extremes of form recognised under each phrase name. Some specimens collected from the same or adjacent populations in different years have noticeably different-sized flowers and leaflets, and the influence of good and bad seasons on morphology cannot be ignored. The effect of environmental differences on phenotype has not been rigorously studied and common-garden experiments would be a useful means to investigate patterns of variation further. Until such a time, *T. gardneri* is recognised here as a single species that is variable across its range.

When these two general *T. gardneri* morphotypes are plotted out, their south/north distribution is striking (Figure 4B), as is the disjunction between them. Many of these disjunctions are attributable to large areas of unsuitable habitat, such as tidal flats, salt lakes and ranges of rocky hills, which may be creating barriers to gene flow, accentuating morphological differences. The majority of collections of *T. gardneri* have been made from track-accessible near-coastal habitats around Carnarvon and Onslow, and along Onslow Road and North West Coastal Highway; the absence of collections along the highway between Manberry and Marilla homesteads is curious and may reflect access issues to areas of suitable habitat. It is notable that at least one of the specimens from this intervening area has somewhat intermediate morphology and continued assessment of the morphological distinctness, or otherwise, of the south/north forms would benefit from additional collections from this area.

Two collections are interestingly placed geographically for their morphology: *G. Perry* 862, collected from the tip of North West Cape, has the same morphology as specimens from the Carnarvon area, and the two sheets of *G. Barnett s.n.* from Carnarvon are a good match for specimens from the Onslow area. In both cases there is some evidence that the specimens may not have been collected from the recorded localities. Perry made 76 collections in August–September 1978 from the North West Cape through to Carnarvon from ten different sites; seven of these are on the North West Cape, with two sites accounting for 37 and 25 records, respectively. While the majority of the collections are dated 'August 1978', 12 have dates recorded (23/08, 28/08, 30/08, 31/08 and 01/09) allowing a critical assessment of Perry's collection data over space and time, and showing that there is some minor discrepancy between the collection dates and the number series across the sites. Given that *G. Perry* 862 is a perfect match for specimens collected near Carnarvon, and one of Perry's collecting sites is from 40 km south of Minilya, near the collecting location for *R. Butcher & R. Davis* RB 1566, there is an outside possibility that the specimen was actually collected from there; revisiting the Vlaming Head area would be required to confirm this. Similarly, all of Barnett's collections at PERTH have non-specific locality statements (e.g. 'Kimberley', 'North West Coast', 'Roebourne' etc.), but there is an annotation on the holotype of *Dicrastylis cordifolia*, recorded as being from 'Carnarvon', that reads 'This specimen was probably collected N of Carnarvon, probably much closer to Onslow than Carnarvon' (B.L. Rye, 06/09/2006). Given that the Barnett collection matches material from near Onslow, it is felt that the locality statement is probably incorrect in this case also.

The sheets of *S. van Leeuwen et al.* PBS 0293 and PBS 0294 state on the specimen labels 'Shrub with purple flowers', but this appears to be a transcription error made during mass specimen processing post-survey, with the colour notes identical to, and attributable to, plants of *T. rosea* Benth. collected from the same site at the same times (i.e. *S. van Leeuwen et al.* PBS 0210 & PBS 0211). Indeed, a sterile collection of *T. gardneri* from this site, collected on a different date (*S. van Leeuwen et al.* PBS 0295), has the same flower colour notes. Later collections of *T. rosea* and *T. gardneri* from the same survey quadrat (*S. Dillon & A. Markey* CR 9002 & CR 9003, respectively) correctly note their flower colour as 'pink-mauve' and 'orange'.

Pedley based his manuscript name on *C.A. Gardner* 3015, one sheet of which (PERTH 02924552) has Gardner's illustrations of a flower, and dissected flower. The type of *T. gardneri* has therefore been selected from one of the southern populations of the species, to match Pedley's concept of the manuscript name.

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References

Bentham, G. (1864). *Flora Australiensis*. Vol. 2. pp. 202–211. (Reeve & Co.: London.)

Butcher, R. (2012). *Tephrosia bidwillii* (Fabaceae: Millettieae) does not occur in Western Australia. *Nuytsia* 22(1): 41–42.

Butcher, R. (2018). *Tephrosia pedleyi* (Fabaceae: Millettieae), a new species from the west Kimberley of Western Australia. *Nuytsia* 29: 69–73.

Butcher, R. & Hurter, P.J.H. (2012). *Tephrosia oxalidea* (Fabaceae: Millettieae), a new species from the Pilbara and Gascoyne bioregions of Western Australia. *Nuytsia* 22(6): 341–349.

Butcher, R., van Leeuwen, S. & Thiele, K. (2017). Taxonomic studies in *Tephrosia* Pers. (Fabaceae) in northern Western Australia. Final report for Rio Tinto Pty Ltd – MesaA Terrestrial Offset Project, 8th May 2017. (Western Australian Herbarium, Department of Parks and Wildlife: Kensington, Western Australia.)

Cowie, I.D. (2004). New species and lectotypifications of some reticulate-nerved *Tephrosia* (Fabaceae) from north-west Australia and the genus *Paratephrosia* re-evaluated. *Nuytsia* 15(2): 163–185.

Department of the Environment (2013). *Australia's bioregions (IBRA)*, IBRA7, Commonwealth of Australia. http://www.environment.gov.au/land/nrs/science/ibra#ibra [accessed 5 May 2017].

Domin, K. (1912). Fifth contribution to the flora of Australia. *Repertorium Specierum Novarum Regni Vegetabilis* 11(16–20): 261–263.

Domin, K. (1926). Beitrage zur flora und pflanzengeographie Australiens. *Bibliotheca Botanica* 22(89): 746–757.

Ellis, B., Daly, D.C., Hickey, L.J., Johnson, K.R., Mitchell, J.D., Wilf, P. & Wing, S.L. (2009). *Manual of leaf architecture*. (Cornell University Press/The New York Botanical Garden Press: New York.)

Ewart, A.J. & Morrison, A. (1913). Contributions to the flora of Australia, no. 21. The Flora of the Northern Territory (Leguminosae). *Proceedings of the Royal Society of Victoria* 1.26(1): 163.

Fitzgerald, W.V. (1918). The botany of the Kimberleys, north-west Australia. *Journal and Proceedings of the Royal Society of Western Australia* 3: 102–224.

Gardner, C.A. (1923). Botanical notes, Kimberley division of Western Australia. Western Australian Forests Department Bulletin No. 32. (Fred. WM. Simpson, Government Printer: Perth.)

Maconochie, J.R. (1980). Three new species of Fabaceae for the Flora of Central Australia. *Journal of the Adelaide Botanic Gardens*. 2(4): 323–328.

von Mueller, F.J.H. (1879). *Fragmenta phytographieae Australiae*. 11(90): 70–71.

von Mueller, F.J.H. (1880). *Fragmenta phytographieae Australiae*. 11(92): 98.

von Mueller, F.J.H. (1883). Definitions of some new Australian plants [continued.]. *The Southern Science Record* 3(5): 127–128.

Pedley, L. (1977). Notes on Leguminosae. 1. *Austrobaileya* 1(1): 25–42.

Pedley, L. (2014). Systematics of *Tephrosia* (Fabaceae: Millettieae) in Queensland: 1. A summary of the classification of the genus, with recognition of two new species allied to *T. varians* (F.M.Bailey) C.T.White. *Austrobaileya* 9(2): 229–243.

Skan, S.A. (1905). *Hooker's Icones Plantarum* 28: pl. 2729.

Tucker, S.C. (1987). Pseudoracemes in papilionoid legumes: their nature, development, and variation. *Botanical Journal of the Linnean Society* 95: 181–206.

Tucker, S.C. (2003). Floral development in legumes. *Plant Physiology* 131: 911–926.

Wheeler, J.R. (1992). *Tephrosia*. *In*: Wheeler, J.R. (ed.), Rye, B.L., Koch, B.L. & Wilson, A.J.G. *Flora of the Kimberley region*. pp. 440–455.

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SHORT COMMUNICATION

Placement of three names in *Cyathostemon*, *Hysterobaeckea* and *Oxymyrrhine* (Myrtaceae: Chamelaucieae)

Baeckea benthamii Trudgen ms, in G. Paczkowska & A.R. Chapman, *West. Austral. Fl.: Descr. Cat.* p. 346 (2000); Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 April 2018].

Notes. This name was recently treated as a synonym of *Hysterobaeckea setifera* Rye, but was accidently placed under *H. setifera* subsp. *meridionalis* Rye (Rye 2018: 77, 104). It is in fact a synonym of *H. setifera* subsp. *setifera*.

Baeckea uncinella Benth. var. **gracilis** W.E.Blackall, in W.E. Blackall & B.J. Grieve, *How Know W. Austral. Wildfl.* 1: 288 (1954), *nom. inval.*

Notes. This name, which is a synonym of *Oxymyrrhine gracilis* Schauer, was overlooked when *Oxymyrrhine* Schauer was last revised (Rye 2009). It was invalidly published by Blackall and Grieve (1954), and was omitted from a later edition of their identification guide (Blackall & Grieve 1980).

Cyathostemon sp. **Mt Dimer** (C. McChesney TRL 4/72) [previously known as *Astartea* sp. Mt Dimer (C. McChesney TRL4/72)], Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 6 April 2018].

Notes. This phrase name has only been applied to a single specimen from near Mt Dimer (*C. McChesney* TRL 4/72), with Trudgen and Rye (2014: 8, 15) noting that this entity needed further investigation to determine its taxonomic status. The Mt Dimer specimen is similar to those housed as *Cyathostemon verrucosus* Trudgen & Rye in having leaves covered by warts that sometimes protrude to form tubercles, but differs in usually having particularly prominent tubercles (see Trudgen & Rye 2014: Figure 1E). Its leaves are uniformly small and somewhat yellowish or brownish, including one completely brown dead leaf, which may indicate that their extreme rugosity is the result of stress from drought or other adverse environmental conditions.

A recent collection of *C. verrucosus* from south-east of Mt Dimer (*K.R. Thiele* 4762: PERTH) has helped to bridge the small gap in morphology and distribution between *C. McChesney* TRL 4/72 and previously collected material of *C. verrucosus*. Consequently, *C.* sp. Mt Dimer is reduced herein to synonymy under *C. verrucosus* and recommended for removal from the *Threatened and Priority Flora list for Western Australia*. *Cyathostemon verrucosus* retains its Priority Three status under Conservation Codes for Western Australian flora (Smith & Jones 2018).

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https://florabase.dpaw.wa.gov.au/nuytsia/
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References

Blackall, W.E. & Grieve, B.J. (1954). *How to know Western Australian wildflowers*. Part 1. (University of Western Australia Press: Nedlands, Western Australia.)

Blackall, W.E. & Grieve, B.J. (1980). *How to know Western Australian wildflowers*. Part 3A. Revised 2nd edn by B.J. Grieve. (University of Western Australia Press: Nedlands, Western Australia.)

Rye, B.L. (2009). Reinstatement of the south-western Australian genus *Oxymyrrhine* (Myrtaceae: Chamelaucieae), with three new species. *Nuytsia* 19: 149–165.

Rye, B.L. (2018). An update to the taxonomy of some Western Australian genera of Myrtaceae tribe Chamelaucieae. 4. *Hysterobaeckea*. *Nuytsia* 29: 75–107.

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 4 July 2018].

Trudgen, M.E. & Rye, B.L. (2014). An update to the taxonomy of some Western Australian genera of Myrtaceae tribe Chamelaucieae. 2. *Cyathostemon*. *Nuytsia* 24: 7–16.

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Triodia pisoliticola (Poaceae), a new species from the Pilbara region, Western Australia, and a description for *T.* sp. Mt Ella (M.E. Trudgen MET 12739)

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Abstract

Barrett, M.D. & Trudgen, M.E. *Triodia pisoliticola*, a new species from the Pilbara region, Western Australia, and description for *T.* sp. Mt Ella (M.E. Trudgen 12739). *Nuytsia* 29: 271–281 (2018). The genus *Triodia* R.Br. is currently undergoing taxonomic revision in the light of intensive botanical survey in remote Australia and molecular phylogenetic data. Several *Triodia* species have been known by phrase names in Western Australia for about 20 years. This paper deals with two of these names, *Triodia* sp. Mt Ella (M.E. Trudgen 12739) and *T.* sp. Robe River (M.E. Trudgen et al. MET 12367), that were first recognised as distinct taxa by one of us. Both species are 'soft' spinifexes with awned lemmas, and are known only from the Pilbara region in Western Australia. *Triodia* sp. Robe River is formally described as *T. pisoliticola* Trudgen & M.D.Barrett. This species is restricted to the western part of the Pilbara bioregion and has flowers morphologically similar to *T. melvillei* (C.E.Hubb.) Lazarides. *Triodia* sp. Mt Ella has floral parts morphologically similar to *T. bitextura* Lazarides; a full description of this entity is given, but it is not formally named pending further revision of the *T. bitextura* complex across northern Australia. Both taxa are currently given a conservation ranking of Priority Three. Both taxa are illustrated, and diagnostic character combinations are given to allow discrimination from all other Pilbara *Triodia* species.

Introduction

Triodia R.Br. (Poaceae) hummock grasses are restricted to mainland Australia, where they are characteristic components of many arid and semi-arid communities. As at late 2017 the genus *Triodia* consisted of 81 described and accepted species (Lazarides 1997; Barrett *et al.* 2005; Armstrong 2008; Barrett & Barrett 2011; Hurry *et al.* 2012; Barrett & Barrett 2015; Crisp *et al.* 2015; Anderson *et al.* 2017a). The genus is being revised by one of us (MB) in the light of material collected during botanical surveys in remote parts of Australia, and molecular phylogenetic data dissecting species complexes (e.g. Anderson *et al.* 2016, 2017a, 2017b for the *T. basedowii* E.Pritz. complex). Several *Triodia* species have been known by phrase names in Western Australia for some years. This paper discusses two of these names, *Triodia* sp. Mt Ella (M.E. Trudgen 12739) and *T.* sp. Robe River (M.E. Trudgen et al. MET 12367), that were first recognised as distinct taxa by one of us (MET) in the 1990s.

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Both species are known only from the Pilbara administrative region in Western Australia (which includes the Pilbara bioregion), and currently have a Western Australian conservation ranking of Priority Three. Diagnostic character combinations are given for both species, but a revised key to *Triodia* is postponed pending description of additional species.

Triodia pisoliticola Trudgen & M.D.Barrett is described as a new species restricted to the far western Hamersley sub-bioregion of the Pilbara bioregion and has flower morphology similar to *T. melvillei* (C.E.Hubb.) Lazarides, but much longer, lax and non-resinous leaves, which give it a distinctly different appearance in the field. It also differs in habitat, growing on the edges and tops of mesas, rather than on alluvial plains as is typical of Pilbara *T. melvillei* (although populations outside the Pilbara are typically restricted to rocky sites).

Triodia sp. Mt Ella (M.E. Trudgen 12739) is mainly restricted to open gullies and slopes in the eastern Hamersley Range, with a disjunct occurrence near the Rudall River, but is morphologically ill-defined against the widespread *T. bitextura* Lazarides *sens. lat.* The latter species occurs from the Kimberley to Queensland, and is morphologically and genetically complex; the diversity and existence of co-occurring discrete forms suggests that multiple taxa exist within *T. bitextura*, but a detailed genetic and morphological study is required for precise definition of these taxa, and to determine whether *T.* sp. Mt Ella may be conspecific with one of the Kimberley or Northern Territory forms. Despite the variation further north, *T.* sp. Mt Ella in the Pilbara is morphologically (and genetically) uniform and geographically discrete, and we have no doubt that it represents a single taxon, although that taxon may ultimately include additional variation from other regions. Consequently, we do not formally name *T.* sp. Mt Ella here, but provide a detailed description of the disjunct Pilbara entity to aid discrimination from other species locally, and as a contribution to the resolution of the *T. bitextura* complex. In the field, *T.* sp. Mt. Ella can be easily separated from co-occurring species by its spreading form, extremely resinous surfaces and very strong smell of resin.

The two taxa discussed in this paper were originally recognised as distinct from then-accepted Pilbara *Triodia* taxa on form, habitat preference and abundance of resin on the leaves. These differences were found to be supported by differences in spikelet morphology when specimens were examined microscopically and compared to other taxa.

Methods and terminology

Descriptions and terminology are based on Lazarides (1997) and Barrett and Barrett (2015).

Leaf anatomy in section was examined by placing a leaf blade in boiling water with a drop of detergent, and manually sectioning with a razor blade. Sections were made primarily to confirm the distribution and number of stomatal grooves on the abaxial and adaxial surfaces, to distinguish epistomatous from amphistomatous anatomy (Toon *et al.* 2015; *cf.* amphistomatous). The term epistomatous is accepted for the soft-type leaf anatomy in which stomatal grooves are lacking on the lateral faces of the abaxial leaf blade, and corresponding increase in lateral colourless mesophyll tissue in section to fill the space. The term epistomatous is synonymous with the term 'soft-type leaf anatomy' that is sometimes used in literature on *Triodia*. The term epistomatous is slightly misleading, since stomatal *grooves* are still present on the lower surface (in a median band), and so there is only a tendency toward a truly epistomatous condition. Although Toon *et al.* (2015) claim that stomata are not present in the few grooves on the abaxial surface in 'soft' *Triodia* species, transections of the leaf blades of most such species show chlorenchyma and 'photosynthetic carbon reduction' (PCR) cells extending all the way

to the lower epidermis at least either side of the central vascular bundle (see supplementary images in Toon *et al.* 2015), which indicates that photosynthesis still occurs there, and by extension stomata must occur in the proximity for efficient gas exchange. The presence of stomata within these grooves is very difficult to observe, in both 'hard' and 'soft' species alike; stomata have been confirmed for very few species. Consequently the term 'stomatal groove' is used here to indicate an abrupt longitudinal fold in the epidermis, homologous in position with the grooves that typically contain stomata, but not necessarily implying that stomata are always present or abundant in the groove.

Glume widths are difficult to measure, the glumes having a curved or folded structure in most species, and even when boiled cannot always be flattened without breaking. To avoid this, widths are measured from the margin to the midrib on both sides and added to give a total width.

The conclusions made here are based on morphological data, but some notes are made on relationships inferred from phylogenetic analyses of sequence alignments from ITS and ETS (Internal Transcribed Spacer and External Transcribed Spacer respectively of the nuclear ribosomal DNA region). Full results of these analyses will be presented elsewhere.

Taxonomy

Triodia pisoliticola Trudgen & M.D.Barrett, *sp. nov.*

Type: near Pannawonica, Western Australia [precise locality withheld for conservation reasons], 19 March 2017, *S. Reiffer s.n.* (*holo*: PERTH 08776296; *iso*: BRI, CANB, DNA, K, MEL).

Triodia sp. Robe River (M.E. Trudgen et al. MET 12367), Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 19 December 2016].

Tussock-forming *perennial*, not resinous, not obviously stoloniferous; *tussocks* compact with lax to sprawling leaves, (10)40–90 cm high, 50–200 cm wide; flowering culms 60–100 cm high. *Culm internodes* all short (never elongated as in *T. claytonii* Lazarides), 0.2–4.2 cm long, and obscured by subtending foliage, red-brown, glabrous or sparsely and patchily appressed-hairy, fastigiated branching absent; aerial roots absent. *Leaf sheaths* 80–155 mm long, 3.5–4.0 mm wide near apex, broader and often papery at base, glabrous or with thin hairs 2–5 mm long on surface, not resinous, straw-coloured, moderately to strongly *c.* 14–16-nerved in central part, becoming chartaceous to almost membranous toward the margins; margins glabrous to densely pilose (often glabrous on one margin, pilose on the other); margins of *orifice* oblique to truncate but not auriculate, with a sparse to dense fringe of straight, becoming woolly-tangled, hairs, the longest hairs 0.6–7.0 mm long. *Ligule* a dense fringe of hairs *c.* 0.5–1.0 mm long; pseudopetiole not distinct. *Leaf blades* flattened-V-shaped when fresh, conduplicate and tightly in-rolled when dry, initially straight but sometimes becoming curled in older and dead leaves, 24–59 cm long, 0.6–1.0 mm wide when rolled (unrolled leaves not seen), when fresh relatively soft and lax, flexible, weakly pungent, glabrous abaxially, adaxial surface densely papillose and sometimes densely woolly-hairy at base, non-resinous, pale to mid-green, drying pale green, stomatal grooves on abaxial surface confined to central part, 4 (2 either side of midline), closely spaced either side of the midline, grooves absent on marginal *c.* 1/3 but finely obscurely ribbed, stomatal grooves on adaxial surface 7 each side of midrib; margins obscurely and minutely scaberulous with prickle hairs *c.* 0.04 mm long. *Panicle* 8.0–23.5 cm long, 0.8–4.5 cm wide, with 26–178 spikelets in total, lanceolate, with branches racemose or more usually ternate on longest branches at least near the base, moderately dense to loose; primary axis angular to ribbed, glabrous or with minute tufts of hairs

0.1–0.4 mm long in branch axils, weakly scaberulous, non-resinous; longest basal panicle branches (1.7–)3.8–8.5 cm long, terete to angular or weakly flattened, with 3–13 loosely arranged, ±uniform-sized spikelets, which are 3.6–12.2 mm apart (measured from base of pedicels) with adjacent glumes partly overlapping; *longest basal pedicels* (lateral on longest lower panicle branches, excluding the terminal pedicels on secondary and ternate branches) 0.9–3.5 mm long, 0.15–0.25 mm wide, becoming slightly thicker just below spikelet, angular to flattened, minutely scabrous; distal lateral pedicels on branch (i.e. excluding terminal one) only slightly shorter than proximal ones; terminal pedicels (including on ternate branches) 4.5–8.0 mm long. *Spikelet* 7.5–21 mm long, 0.8–2.8 mm wide (excluding awns), loosely 5–12-flowered with 4–11 fertile florets and apparently 0–2 sterile florets at apex (but these possibly merely immature), linear, subterete or compressed; lowest rachilla internode 1.0–1.7 mm long, *c.* 0.15–0.25 mm diam., minutely scabrous; spikelets disarticulating above glumes and at rachilla internodes at maturity. *Lower glume* 6.2–8.8 mm long, 0.9–1.6 mm wide, narrowly lanceolate, L:W 5.0–7.2, sharply acute to acuminate, shorter than the combined spikelet florets (excluding awns), chartaceous, scarious, lacking differentiated membranous margins, with minute scabrosities less than 0.05 mm long over whole surface, 3–5-nerved, the midnerve scarcely raised, lateral nerves scarcely raised, margins glabrous. *Upper glume* inserted *c.* 0.3–0.5 mm above lower glume, 6.5–8.5 mm long, 3–5-nerved, similar to and subequal to lower glume, shorter than the combined florets. *Lowest lemma* 8.0–13.0 mm long including awns, lanceolate, not bitextured, uniformly stiffly chartaceous to weakly indurated except for narrow membranous margin, deeply 3-lobed, 3-awned; body 3.7–5 mm long including callus, *c.* 1–1.2 mm wide, basal 1/4–2/3 with dense, appressed to ascending hairs 0.15–0.6 mm long in 1–5 rows either side of the midnerve and also along submargins or frequently almost glabrous except for 2 rows of dense hairs either side of midnerve, nerves 9, the upper part with 3 groups of 3 obscure nerves radiating into lobes; midlobe 4.2–9.0 mm long including awn, triangular at base abruptly narrowing into awn, slightly to distinctly narrower to slightly broader than lateral lobes; lateral lobes 2.8–5.7 mm long including awn, narrowly triangular at base soon narrowing into an awn, margins with a very narrow membranous wing; *callus* 0.4–0.6 mm long, straight to slightly curved, attached obliquely, acute to abruptly blunt in face view, acute in profile, white-bearded on lateral margins leaving narrow to broad glabrous midline, the longest hairs 0.15–0.7 mm long. *Upper lemmas* similar to but smaller than lowest lemma. *Palea* of basal lemma distinctly longer than lemma body, 4.2–6.0 mm long, 0.7–1.0 mm wide, lanceolate, 2-keeled, not bitextured, membranous to chartaceous, glabrous but with dense tiny tubercles (the bases of tiny trichomes) in the lower half, apex acute; keels raised and not winged or with a narrow wing up to *c.* 0.1 mm wide, keel margin scabrous in basal 1/4–2/3, becoming shortly ciliate with cilia *c.* 0.1–0.2 mm long near apex; flaps 0.1–0.4 mm wide, broadest in central part, narrower than 1/2 width of the palea body and not overlapping, entire. *Lodicules* 2, 0.3–0.8 mm long, apex truncate, undulate, glabrous. *Anthers* 3, 2.5–2.9 mm long, exserted at maturity. *Styles* 2, 1.3–1.6 mm long. *Caryopsis* 1.8–2.0 mm long, *c.* 0.5 mm wide. (Figure 1)

Diagnostic features. Foliage non-resinous. Leaf blades epistomatous (soft-type), 24–59 cm long. Spikelets 5–12-flowered, with 4–11 fertile florets and 0–2 sterile florets. Glumes narrowly lanceolate, 3–5-nerved. Lemmas deeply 3-lobed and 3-awned, body uniformly textured, with appressed hairs arranged in many longitudinal lines (or sometimes glabrous in the central zone). Palea minutely tuberculate in lower half, glabrous, not winged.

Selected specimens examined. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 10 Feb. 2015, *M.D. Barrett & B.M. Anderson* MDB 4546 (PERTH); 8 Aug. 2008, *A. Douglas & R. Graham* LCH 24930 (PERTH); 12 Feb. 2008, *R. Graham* LCH 24929 (PERTH); 14 Aug. 2010, *N. Krawczyk* NK/03 (PERTH); 15 Aug. 2015, *S. van Leeuwen et al.* PBS 0406 (PERTH); 14 Aug. 2005, *S. van Leeuwen et al.* PBS 0406 (PERTH); 31 Aug. 2006, *S. van Leeuwen* PBS 3623 (PERTH); 25 Mar. 2010, *B. Mathews* BM 50 (PERTH); 1 Sep. 2010, *B. Mathews* BM 53 (PERTH); 16 June

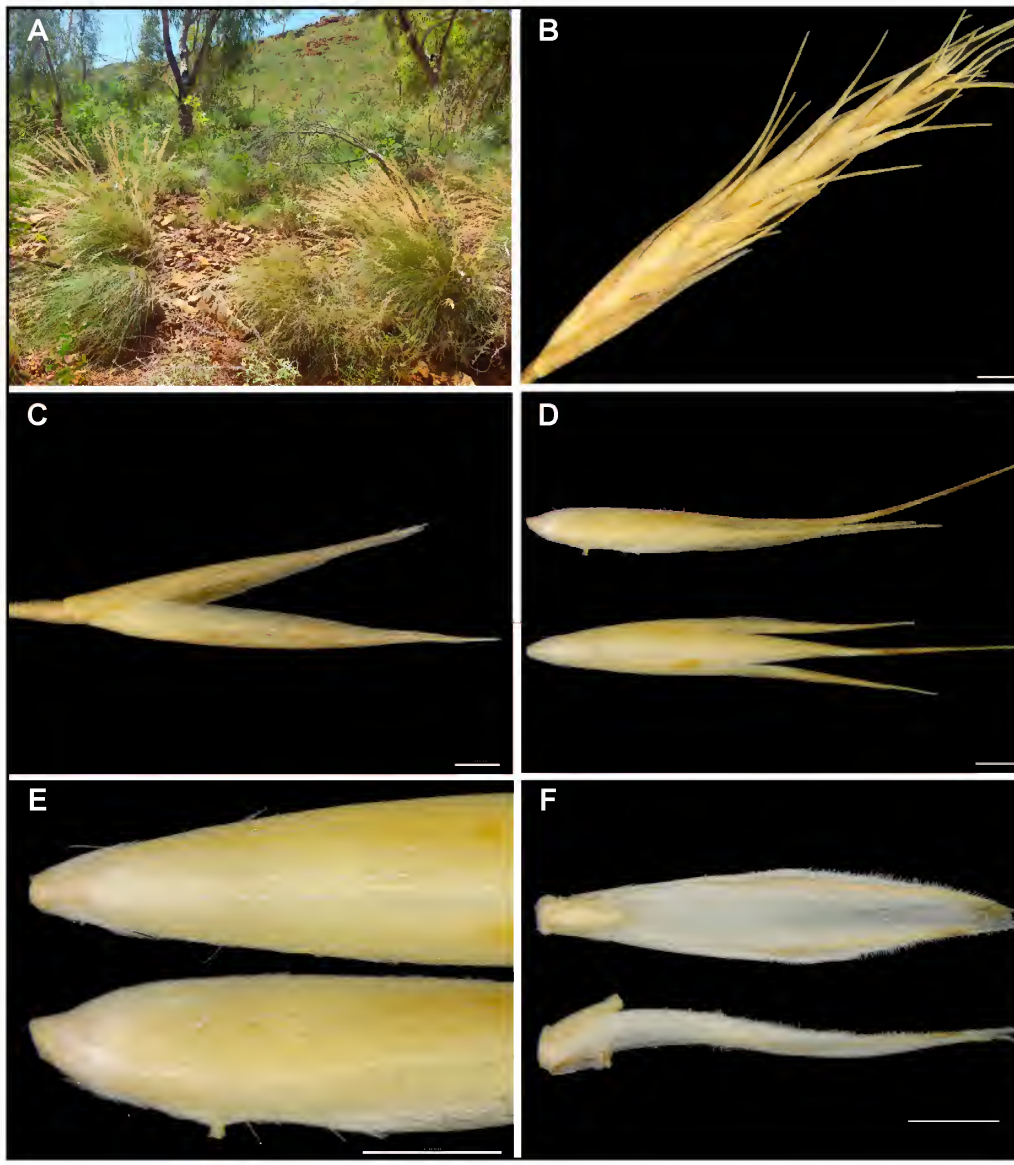

Figure 1. *Triodia pisoliticola*. A – flowering plant *in situ* showing long, lax leaf blades; B – spikelet, showing the awned lemmas and the glumes shorter than combined florets; C – glumes, showing chartaceous texture; D – lemmas of basal floret in side and face view showing relative proportions of body and lobes; E – base of lemmas of basal floret in side and face view, showing hairs in longitudinal rows becoming glabrous in some areas, and callus shape; F – paleas in side and face view showing lack of hairs and minute tubercles in basal half, and very shortly winged lemma keels. Scale bars = 1 mm. Images from *S. Reiffer s.n.* (9/3/2017). Photographs by S. Reiffer (A) and M. Barrett (B–F).

2011, *B. Mathews* BM 71 (PERTH); 14 Mar. 2011, *B. Mathews* BM 83 (PERTH); 31 Mar. 1994, *A.A. Mitchell* PRP 200 (PERTH); 11 July 1991, *M.E. Trudgen & S.M. Maley* MET 10114 (PERTH); 2 May 1995, *M.E. Trudgen, M. Trudgen & S. Deluca* MET 12367 (PERTH); 23 Aug. 2009, *M.S. Trudgen* MST 366 (PERTH); 18 Feb. 2008, *D. True* LCH 24931 (PERTH); 15 June 2007, *D. True, S. Kern & K. McMaster* LCH 14701 (PERTH).

Phenology. Fertile collections have been made between February and August, but seed has dropped from almost all plants by late March in most years.

Distribution and habitat. All known locations of *T. pisoliticola* are in the western part of the Pilbara bioregion, with a range of about 200 km. The main areas of occurrence are in the Robe River Valley and the headwaters of the Cane River, with smaller occurrences to the north of the Robe River and east of the Cane River, and in the western Hamersley Range. Most of the known locations are either on the edges of mesas capped with Robe Pisolite or on the tops of the mesas of that geology. In the Robe River Valley *T. pisoliticola* is usually on the edges of the mesas, while the Cane River occurrences are partly on the edges of the mesas and partly on the flat tops of the mesas. A few of the eastern occurrences are on other iron-rich geology.

Conservation status. *Triodia pisoliticola* is listed by Smith and Jones (2018) as Priority Three under Conservation Codes for Western Australian Flora, under the name *T.* sp. Robe River (M.E. Trudgen et al. MET 12367). It is known from nearly 50 collections in herbaria, with heavy representation from the area south of Pannawonica, but sterile material from more locations has been seen by one of us (MET) who has also seen more locations in the Robe River Valley. At many locations it is dominant in the ground layer of the vegetation, but occurrences vary in size from quite small to fairly large. There are no known records of this taxon in the conservation estate and all occur within live mining and exploration tenements in the Pilbara. *Triodia* sp. Robe River assemblages of mesas of the West Pilbara are also listed as a Priority Ecological Community (PEC). The western part of the distribution extends for about 120 km from north to south, the area of occurrence then extends very patchily from the southern end to the east.

Etymology. The epithet is from pisolite, a geological term for a conglomerate of pea-sized pieces such as gravel (in turn derived from Latin *pisum*, pea), and Latin *-cola*, dweller.

Notes. Using the subgeneric groups of Lazarides *et al.* (2005), *T. pisoliticola* belongs to the 'Schinzii group', closest morphologically to *T. melvillei*; both share awned lemma lobes and hairs arranged in lines on the lemma body. *Triodia pisoliticola* was treated under *T. melvillei* by Lazarides (1997) and Lazarides *et al.* (2005). The two species are easily distinguished, since *T. pisoliticola* is non-resinous and the leaf blades are slender, long and lax, while *T. melvillei* is copiously resinous on the foliage and the leaves are stiffer and usually shorter [15–35(–46) mm long in *T. melvillei*; 24–59 cm long in *T. pisoliticola*]. *Triodia melvillei* differs further from *T. pisoliticola* by having three or four reduced infertile florets at the apex of spikelets (only 0–2 reduced infertile florets terminating spikelets in *T. pisoliticola*). Nuclear ribosomal and chloroplast genes (data not shown) suggest that *T. melvillei* and *T. pisoliticola* are not sister taxa, despite their floral similarities.

The closest phylogenetic relative to *T. pisoliticola* appears to be *T.* sp. Karijini (S. van Leeuwen 4111), a plant of high mountains (>900 m) in the eastern Hamersley Range. *Triodia* sp. Karijini is similar to *T. pisoliticola*, but forms smaller, denser tussocks, has lobed lemmas with midlobe 2–3 mm long, (prominently awned and 4.2–9.0 mm long in *T. pisoliticola*), resinous to non-resinous foliage (always non-resinous in *T. pisoliticola*), and leaf blades generally shorter (19.0–33.5 mm long, compared to 25–59 mm long in *T. pisoliticola*).

Other than *T. melvillei* discussed above, four species with epistomatous (soft-type) leaf anatomy with long-awned but not bitextured lemmas have been described: *T. bunglensis* (S.W.L.Jacobs) Lazarides, *T. bynoei* (C.E.Hubb.) Lazarides (*sens. lat.*), *T. salina* Lazarides and *T. prona* Lazarides. All four occur

in the Kimberley or central deserts or the Top End region of the Northern Territory, disjunct from *T. pisoliticola* in the western Pilbara. The first three species differ in having copiously resinous foliage (non-resinous in *T. pisoliticola*) and hairs scattered over the lower lemma body (arranged in 2–many longitudinal rows in *T. pisoliticola*). *Triodia bunglensis* differs further in having very compact, dense inflorescences (loose in *T. pisoliticola*). *Triodia bynoei* (*sens. lat.*) differs further in frequently having reduced awns on the lateral lobes on the lowest lemma. *Triodia salina* differs further in having a distinctly stoloniferous habit (tightly clumping, with stolons not exceeding the parent tussock in *T. pisoliticola*). *Triodia prona* is an enigmatic taxon that has not been relocated since the type collection in 1963 (Gibson 2016), and is unique in its decumbent inflorescence.

Triodia triaristata Lazarides was also considered part of the awned 'Schinzii group' by Lazarides *et al.* (2005), but has acuminate to short-awned lemma lobes, with the awns 1–3 mm long when present (4.2–9 mm long in *T. pisoliticola*).

The vernacular name Mesa Spinifex is suggested.

Triodia sp. **Mt Ella (M.E. Trudgen 12739)**, Western Australian Herbarium, in *FloraBase*, https://florabase.dpaw.wa.gov.au/ [accessed 15 May 2017].

Hummock-forming *perennial*, very resinous, sometimes conspicuously stoloniferous (e.g. *M.E. Trudgen & M. Trudgen* MET 12774); hummocks loose, 30–60 cm high, 40–80 cm wide; flowering culms 70–100 cm high. *Culm internodes* short to long, 0.3–15.3 cm long, some exserted from subtending foliage, red-brown, glabrous, fastigiated branching absent; aerial roots not seen. *Leaf sheaths* 2.5–3.5 mm wide near apex, glabrous on surface, resinous, green to straw-coloured, prominently nerved; margins glabrous or more usually ciliate with hairs 0.5–2.0 mm long; margins of orifice truncate, with a dense fringe of hairs matted in resin, the longest hairs 2.5–5.0 mm long. *Ligule* a dense fringe of hairs *c.* 1.0 mm long; pseudopetiole not distinct. *Leaf blades* flattened-V-shaped when fresh, conduplicate and tightly in-rolled when dry, initially straight becoming curved in older and dead leaves, 8–19 cm long, 0.7–0.8 mm wide when rolled (unrolled leaves 2.4–2.6 mm wide), when fresh relatively flexible, weakly pungent, glabrous abaxially, adaxial surface densely papillose, resinous over abaxial surface, bright green, drying dull green, stomatal grooves on abaxial surface confined to central part, 2–4, (1 or 2 either side of small midrib), unequally spaced, grooves absent on marginal *c.* 1/3 but finely obscurely ribbed, stomatal grooves on abaxial surface 6–7 each side of midrib; margins minutely scaberulous with prickle hairs 0.05–0.15 mm long. *Panicle* 7.5–20.0 cm long, 1.5–5.0 cm wide, with 28–84 spikelets, lanceolate to narrowly lanceolate, with branches openly racemose or basal-most ones sometimes ternate at the base, moderately dense to loose; primary axis angular and ribbed, glabrous or with minute tufts of hairs 0.5–1.7 mm long in branch axils, resinous or non-resinous; longest basal panicle branches 3.8–7.0 cm long, terete to angular or weakly flattened, with 4–8 loosely arranged, ±uniform-sized spikelets, which are 2.8–10.0 mm apart (measured from base of pedicels) with adjacent glumes shortly separated or partly overlapping; *longest basal pedicels* (lateral on the longest lower panicle branches) 5.0–15.5 mm long, 0.1–0.2 mm wide, ±filiform, becoming distinctly thicker just below spikelet, subterete to angular, minutely scabrous; upper lateral pedicels on branch only slightly shorter than lower one; terminal pedicel 6.5–11.0 mm long. *Spikelet* 6.3–12.0 mm long, 1.5–3.5 mm wide (including glumes but excluding awns), spikelet excluding glumes and awns 4.0–10.0 mm long, loosely 4–6-flowered with 2–4 fertile florets (apparently 1 or 2 sterile florets at apex, but these possibly merely immature), linear to narrowly lanceolate, not or only slightly compressed at maturity; lowest rachilla internode *c.* 1.3–2.0 mm long, *c.* 0.1 mm diam., minutely scabrous; spikelets disarticulating above glumes and at rachilla internodes at maturity. *Lower glume* 6.3–10.5(–12) mm long, 1.1–2.0 mm wide, L:W 5.0–6.6, narrowly lanceolate, acute to shortly acuminate, shortly to distinctly longer than the combined spikelet florets (excluding

the awns), submembranous and subtranslucent, with undifferentiated margins, smooth or with very fine, minute and obscure scabrosities to *c.* 0.05 mm long mostly in marginal areas, 3–5-nerved, the midnerve only slightly raised, lateral nerves slightly raised, margins glabrous. *Upper glume* inserted 0.2–0.4 mm above lower glume, 6.1–10.3 mm long, 3–5-nerved, similar to or slightly shorter or longer than lower glume, distinctly longer than the combined florets (excluding awns). *Lowest lemma* 11.3–15.0 mm long including awns, linear to lanceolate, uniformly textured when immature becoming bitextured with a transverse demarcation line (lower part indurated, upper part membranous-chartaceous, underside developing a thickened transverse callosity at the junction of the texture change) developing by anthesis, deeply 3-lobed and 3-awned; body 3.1–4.2 mm long including callus, the indurated part 1.8–2.7 mm long with dense, appressed hairs 0.3–0.5 mm long reaching to apex of indurated part and apparently nerveless, the membranous part 0.6–1.0 mm long and glabrous with 3 groups of 3 obscure nerves radiating into lobes; midlobe including awn 6.4–10.5 mm long, narrowly triangular at base narrowing into an awn, equal in width to lateral lobes; lateral lobes including awn 4.0–7.6 mm long, narrowly triangular at base narrowing into an awn, margins with a very narrow membranous wing; *callus* 0.2–0.35 mm long, slightly curved in profile, attached obliquely, acute to blunt in face view, acute in profile, white-bearded except in midline, the longest hairs 0.4–0.8 mm long. *Upper lemmas* similar to but smaller than lowest lemma. *Palea* of basal lemma longer than lemma body, 3.9–4.7 mm long, 0.6–1.0 mm wide, oblanceolate, not keeled, obscurely 2-nerved with nerves only partly running into membranous part, distinctly bitextured, lower part indurated and hairy in upper 1/2–2/3 or lower half, upper part translucent-membranous and glabrous, apex acute to truncate; keels obscured in indurated part and not winged (a brief wing *c.* 0.1–0.2 mm wide at the nerved base of membranous part of palea); flaps *c.* 0.1–0.2 mm wide, broadest in central part, narrower than 1/2 width of the palea body and not overlapping, entire. *Lodicules* 0.5–0.7 mm long, obtriangular, apex ±truncate, glabrous or ciliate. *Anthers* 3, 2.3–2.5 mm long, exserted at maturity. *Styles* 2, *c.* 1.5–1.6 mm long. *Caryopsis* not seen. (Figure 2)

Diagnostic features. Foliage copiously resinous. Leaf sheaths glabrous on surfaces, margins ciliate or sometimes glabrous. Leaves epistomatous (soft-type), lacking stomatal grooves on the lateral margins of the abaxial surface. Spikelets 4–6-flowered with 2–4 fertile florets. Glumes 6.3–10.5(–12) mm long, longer than the combined florets. Lemmas with short callus 0.2–0.35 mm long, body bitextured with upper membranous part sharply demarcated from lower indurated part by a transverse line, lobes awned. Palea bitextured, the lower indurated part hairy.

Selected specimens. WESTERN AUSTRALIA: [localities withheld for conservation reasons] 8 Mar. 2012, *M.D. Barrett & W. Lewandrowski* MDB 3910 (CANB, DNA, K, PERTH); 1 Feb 2011, *J. Bull & G. Hopkinson* ONS JIN 2 (PERTH); 4 Feb. 2011, *J. Bull & G. Hopkinson* ONS M 4 (PERTH); 9 Aug. 2011, *J. Bull & D. Roberts* ONS wp 046.01 (PERTH); 26 Apr. 2013, *J. Bull & D. Roberts* ONS A 81 (PERTH); 6 May 2002, *D.J. Edinger & G. Marsh* DJE 3461 (PERTH); 22 May 1971, *A.S. George* 10783 (PERTH); 20 Mar. 2010, *K. McCann* ENV 6 (PERTH); 27 Mar. 2013, *S. Reiffer* SRe 208 (PERTH); 19 May 1995, *M.E. Trudgen* MET 12739 (PERTH); 29 May 1997, *M.E. Trudgen* MET 15705 (PERTH); 22 May 1995, *M.E. Trudgen & M. Trudgen* MET 12778 (PERTH).

Phenology. Fertile collections have been made in February and March.

Distribution and habitat. *Triodia* sp. Mt Ella is restricted to a small area mainly in the central to eastern Hamersley Range but extends to the south of the range, and also has disjunct occurrences east of Newman (*J. Bull & D. Roberts* ONS 19jb 143.01) and south of the Rudall River (*A.S. George* 10783). The Hamersley Range populations mainly occur in the Mt Meharry, Mt Robinson, and Mt Ella areas and south from there to the Angelo River area and to near Turee Creek Station (*D.J. Edinger & G. Marsh* DJE 3461). Individual occurrences in the Hamersley Range are small in area, mainly occurring at the

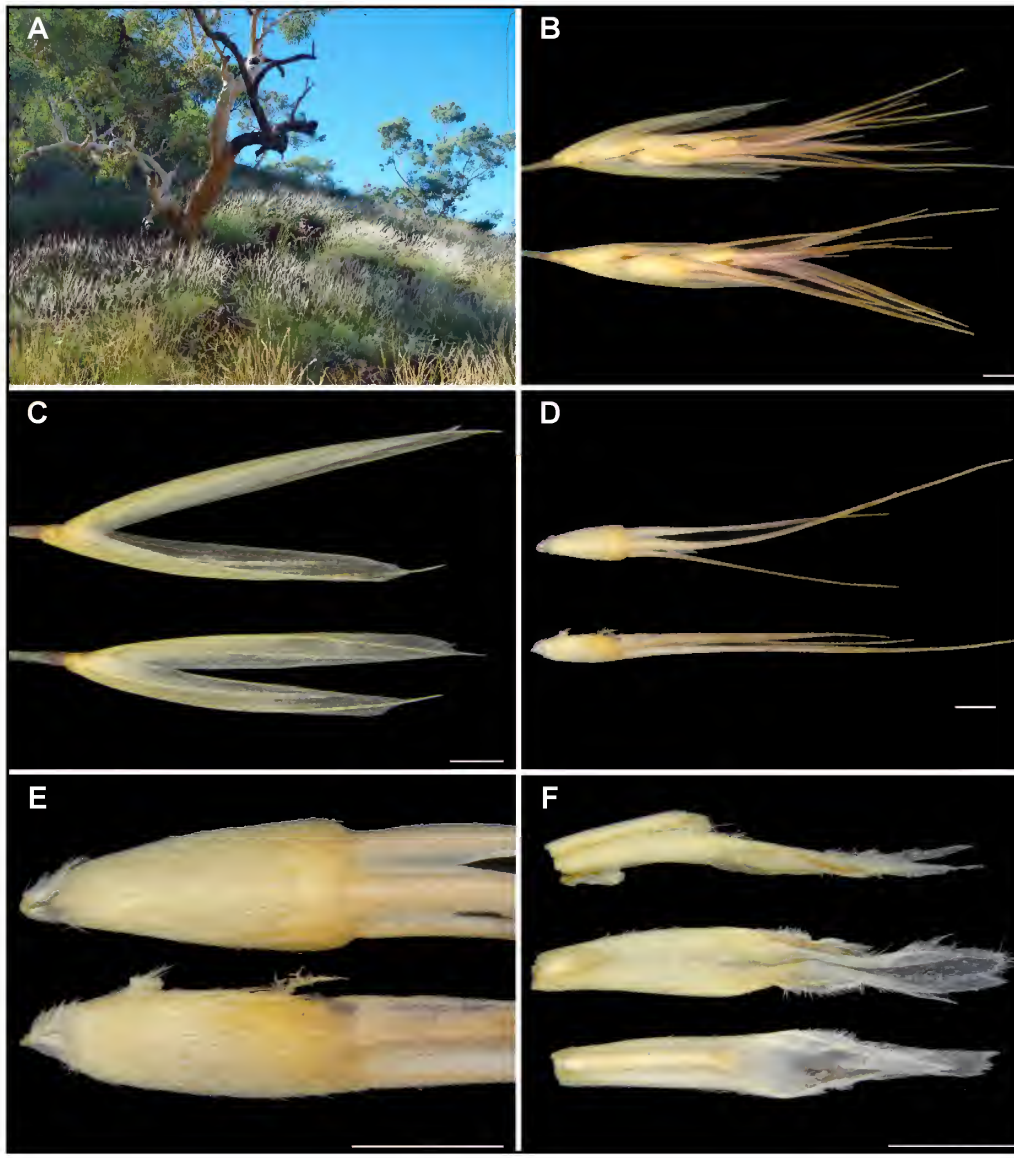

Figure 2. *Triodia* sp. Mt Ella. A – flowering plants *in situ* at base of steep ironstone slope, with *T. pungens* R.Br.in foreground, B – spikelets, showing glumes longer than the combined florets (excluding awns); C – glumes, showing membranous texture and three nerves; D – lemma of basal floret in side and face view showing awns; E – lemma of basal floret, detail of base in side and face view, showing indurated lower part separated from membranous upper part with a sharp demarcation line, uniformly distributed hairs over indurated part, and short callus; F – palea of basal floret (partially crumpled) in side and face view showing indurated base and membranous apex, with hairs over the indurated part. Scale bars = 1 mm. Images from *M.D. Barrett & W. Lewandrowksi* MDB 3910. Photographs by M. Barrett.

bases of open to slight gullies on the mid- to upper slopes of large hills; however, some records are from gorges and ridges. Some occurrences are associated with iron-rich substrate in the West Angelas mining area, but the main factor affecting distribution is likely to be the deeper (moisture retaining) soils at the bases of gullies. Most records are from outcropping ironstone or ironstone gravel; the Rudall River occurrence is from creek beds on unknown geology.

Conservation status. *Triodia* sp. Mt Ella (M.E. Trudgen 12739) is listed by Smith and Jones (2018) as Priority Three under Conservation Codes for Western Australian Flora. It is mostly known from 33 collections from an area about 100 km north to south and about 40 km at its widest point in the West Angelas area. In this area *T.* sp. Mt Ella is usually dominant in the grass layer where it occurs; however, the individual occurrences are quite small, often being only a few tens of metres across. The size of the disjunct populations east of the Pilbara bioregion are not known.

Notes. The Rudall River specimens of *T.* sp. Mt Ella were cited as part of a broad concept of *T. bitextura* by Lazarides (1997) and Lazarides *et al.* (2005), while Hamersley Range specimens were not seen for those treatments. *Triodia bitextura* as treated by Lazarides (*loc. cit.*) is a complex of morphologically similar but apparently genetically divergent variants, some of which can co-occur, indicative of reproductive isolation despite subtle morphological differences. One of these variants, mentioned as a form of *T. bitextura* with hirsute sheath surfaces by Lazarides (1997), has already been described as the Pilbara endemic *T. basitricha* M.D.Barrett (Barrett & Barrett 2015). *Triodia* sp. Mt Ella accounts for the majority of remaining Pilbara collections formerly included under *T. bitextura*. Two additional unusual Pilbara '*T. bitextura*' forms are known: *P.J. Davidson* 2026 (CANB) from near Pannawonica should perhaps be included under *T. basitricha*, but lacks the diagnostic sheath hairs, and requires additional study, while another variant east of Port Hedland has longer glumes and more glume nerves than any member of *T. bitextura sens. lat.*, and appears to have more affinity to *T. schinzii* (with which it co-occurs) rather than any member of the *T. bitextura* complex; this form is to be described elsewhere (Barrett, in prep.).

Several described species share with *T.* sp. Mt Ella the distinctive bitextured mature lemma, where the indurated lower part is sharply demarcated from the upper membranous part by a transverse line that is usually thickened on the inner surface, and can eventually become an abscission line: these are *T. acutispicula* Lazarides, *T. basitricha*, *T. caelestialis* G.Armstrong, *T. helmsii* C.E.Hubb.) Lazarides and *T. schinzii* (Henrard) Lazarides. *Triodia* sp. Mt Ella can be distinguished from *T. basitricha* in being copiously resinous and lacking hairs on the leaf sheath surfaces (not or weakly resinous and with hairy leaf sheath surfaces in *T. basitricha*). *Triodia* sp. Mt Ella is distinguished from *T. acutispicula* and *T. caelestialis* in having numerous appressed hairs all over the lemma surfaces (glabrous, or with minute hairs only along the midline in *T. acutispicula* and *T. caelestialis* respectively). *Triodia* sp. Mt Ella is distinguished from *T. schinzii* (and *T. helmsii* which appears to be synonymous with *T. schinzii*; Barrett, in prep.) in having a shorter, blunt to broadly acute callus and shorter glumes 6.3–10.5(–12) mm long (callus sharply pungent and 0.8–1.5 mm long, and glumes (12.7–)15.5–26.0 mm long in *T. schinzii*).

Triodia bitextura sens. lat. is morphologically variable, covering the range of variation in *T.* sp. Mt Ella. While this latter taxon has the unusual combination of copiously resinous foliage, usually ciliate leaf sheath margins, a combined floret length of 6.3–10.0 mm, and glumes that are 6.3–10.5(–12) mm long and longer than the combined florets, it is not necessarily unique within the *T. bitextura sens. lat.* assemblage (foliage most commonly non-resinous to weakly resinous, but sometimes strongly resinous; sheath margin glabrous or ciliate; combined florets 9–20 mm long,; glumes 7–17 mm long and shorter to longer than combined florets). Of note, however, is that the short spikelets, and corresponding combination of relatively short glumes *and* glumes longer than combined florets are especially unusual, and potentially diagnostic.

Immature lemmas can lack any evidence of a transverse line, and *T.* sp. Mt Ella could then be mistaken for *T. melvillei*. This species, however, has hairs aligned in distinct rows on the lemma body, compared with a more or less uniform distribution over the surface in *T.* sp. Mt Ella.

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References

Anderson, B.M., Barrett, M.D., Krauss, S.L. & Thiele, K. (2016). Untangling a species complex of arid zone grasses (*Triodia*) reveals patterns congruent with co-occurring animals. *Molecular Phylogenetics and Evolution* 101: 142–162. doi:10.1016/j.ympev.2016.05.014.

Anderson, B.M., Thiele, K.R. & Barrett, M.D. (2017a). A revision of the *Triodia basedowii* species complex and close relatives (Poaceae: Chloridoideae). *Australian Systematic Botany* 30: 117–229.

Anderson, B.M., Thiele, K.R., Krauss, S.L. & Barrett, M.D. (2017b). Genotyping-by-sequencing in a species complex of Australian hummock grasses (*Triodia*): methodological insights and phylogenetic resolution. *PLOSOne* 12(1): e0171053. doi:10.1371/journal.pone.0171053.

Armstrong, G. (2008). *Triodia caelestialis* (Triodieae: Chloridoideae: Poaceae), a new species from the central Kimberley, Western Australia. *Journal of the Royal Society of Western Australia* 91: 313–317.

Barrett, R.L., Wells, G.B. & Dixon, K.W. (2005). New taxa and combinations: Subfam. Chloridoideae, Trib. Triodieae, *Triodia*. *In*: Mallett, K. (ed.). *Flora of Australia* Vol. 44B. pp. 458–459. (CSIRO Publishing: Melbourne.)

Barrett, R.L. & Barrett, M.D. (2011). Two new species of *Triodia* (Poaceae: Triodieae) from the Kimberley region of Western Australia. *Telopea* 13: 57–67.

Barrett, R.L. & Barrett, M.D. (2015). Twenty-seven new species of vascular plants from Western Australia. *Nuytsia* 26: 21–87.

Crisp, M.D., Mant, J., Toon, A. & Cook, L.G. (2015). Australian spinifex grasses: new names in *Triodia* for *Monodia* and *Symplectrodia*. *Phytotaxa* 230: 293–296.

Gibson, N. (2016). Western Australian plant taxa not collected for more than 50 years. *Nuytsia* 27: 139–164.

Hurry, C.R., Walsh, N.G. & Murphy, D.J. (2012). A taxonomic review of *Triodia bunicola* and *T. scariosa* (Poaceae: Chloridoideae), based on morphological and molecular data. *Australian Systematic Botany* 25: 304–312. doi:10.1071/SB10044.

Lazarides, M. (1997). A revision of *Triodia* including *Plectrachne* (Poaceae, Eragrostideae, Triodiinae). *Australian Systematic Botany* 10: 381–489. doi:10.1071/SB96012.

Lazarides, M., Weiller, C. & McCusker, A. (2005). *Triodia*. *In*: Mallett, K. (ed.). *Flora of Australia* Vol. 44B. pp. 203–256.

Smith, M.G. & Jones, A. (2018). *Threatened and Priority Flora list 16 January 2018*. Department of Biodiversity, Conservation and Attractions. https://www.dpaw.wa.gov.au/plants-and-animals/threatened-species-and-communities/threatened-plants [accessed 29 October 2018].

Toon, A., Crisp, M.D., Gamage H., Mant, J., Morris, D.C., Schmidt, S., Cook, L.G. (2015). Key innovation or adaptive change? A test of leaf traits using Triodiinae in Australia. *Scientific Reports* 5: 12398.

Referees for Volume 29

The assistance of referees in providing expert review of papers submitted to *Nuytsia* is gratefully acknowledged. The referees consulted for Volume 29 include those listed below and one anonymous reviewer. Each paper was also refereed internally by *Nuytsia* Editorial Committee members.

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CONSERVATION CODES
for Western Australian Flora and Fauna

Specially protected fauna or flora are species* which have been adequately searched for and are deemed to be, in the wild, either rare, at risk of extinction, or otherwise in need of special protection, and have been gazetted as such.

T Threatened species

Published as Specially Protected under the *Wildlife Conservation Act 1950*, and listed under Schedules 1 to 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora (which may also be referred to as Declared Rare Flora).

Threatened fauna is that subset of 'Specially Protected Fauna' declared to be 'likely to become extinct' pursuant to section 14(4) of the Wildlife Conservation Act.

Threatened flora is flora that has been declared to be 'likely to become extinct or is rare, or otherwise in need of special protection', pursuant to section 23F(2) of the Wildlife Conservation Act.

The assessment of the conservation status of these species is based on their national extent and ranked according to their level of threat using IUCN Red List categories and criteria as detailed below.

CR Critically endangered species

Threatened species considered to be facing an extremely high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 1 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EN Endangered species

Threatened species considered to be facing a very high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 2 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

VU Vulnerable species

Threatened species considered to be facing a high risk of extinction in the wild. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 3 of the Wildlife Conservation (Specially Protected Fauna) Notice for Threatened Fauna and Wildlife Conservation (Rare Flora) Notice for Threatened Flora.

EX Presumed extinct species

Species which have been adequately searched for and there is no reasonable doubt that the last individual

has died. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 4 of the Wildlife Conservation (Specially Protected Fauna) Notice for Presumed Extinct Fauna and Wildlife Conservation (Rare Flora) Notice for Presumed Extinct Flora.

IA Migratory birds protected under an international agreement

Birds that are subject to an agreement between the government of Australia and the governments of Japan (JAMBA), China (CAMBA) and The Republic of Korea (ROKAMBA), and the Bonn Convention, relating to the protection of migratory birds. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 5 of the Wildlife Conservation (Specially Protected Fauna) Notice.

CD Conservation dependent fauna

Fauna of special conservation need being species dependent on ongoing conservation intervention to prevent it becoming eligible for listing as threatened. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 6 of the Wildlife Conservation (Specially Protected Fauna) Notice.

OS Other specially protected fauna

Fauna otherwise in need of special protection to ensure their conservation. Published as Specially Protected under the *Wildlife Conservation Act 1950*, in Schedule 7 of the Wildlife Conservation (Specially Protected Fauna) Notice.

P Priority species

Possibly threatened species that do not meet survey criteria, or are otherwise data deficient, are added to the Priority Fauna or Priority Flora Lists under Priorities 1, 2 or 3. These three categories are ranked in order of priority for survey and evaluation of conservation status so that consideration can be given to their declaration as threatened flora or fauna.

Species that are adequately known, are rare but not threatened, or meet criteria for near threatened, or that have been recently removed from the threatened species or other specially protected fauna lists for other than taxonomic reasons, are placed in Priority 4. These species require regular monitoring.

Assessment of Priority codes is based on the Western Australian distribution of the species, unless the distribution in WA is part of a contiguous population extending into adjacent States, as defined by the known spread of locations.

1 Priority 1: Poorly-known species

Species that are known from one or a few locations (generally five or less) which are potentially at risk. All occurrences are either: very small; or on lands not managed for conservation, e.g. agricultural or pastoral lands, urban areas, road and rail reserves, gravel reserves and active mineral leases; or otherwise under threat of habitat destruction or degradation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under immediate threat from known threatening processes. Such species are in urgent need of further survey.

2 Priority 2: Poorly-known species

Species that are known from one or a few locations (generally five or less), some of which are on lands managed primarily for nature conservation, e.g. national parks, conservation parks, nature reserves and other lands with secure tenure being managed for conservation. Species may be included if they are comparatively well known from one or more locations but do not meet adequacy of survey requirements and appear to be under threat from known threatening processes. Such species are in urgent need of further survey.

3 Priority 3: Poorly-known species

Species that are known from several locations, and the species does not appear to be under imminent threat, or from few but widespread locations with either large population size or significant remaining areas of apparently suitable habitat, much of it not under imminent threat. Species may be included if they are comparatively well known from several locations but do not meet adequacy of survey requirements and known threatening processes exist that could affect them. Such species are in need of further survey.

4 Priority 4: Rare, Near Threatened and other species in need of monitoring

(a) Rare. Species that are considered to have been adequately surveyed, or for which sufficient knowledge is available, and that are considered not currently threatened or in need of special protection, but could be if present circumstances change. These species are usually represented on conservation lands.

(b) Near Threatened. Species that are considered to have been adequately surveyed and that are close to qualifying for Vulnerable, but are not listed as Conservation Dependent.

(c) Species that have been removed from the list of threatened species during the past five years for reasons other than taxonomy.

*Species includes all taxa (plural of taxon - a classificatory group of any taxonomic rank, e.g. a family, genus, species or any infraspecific category i.e. subspecies or variety, or a distinct population).

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